CHOLERA:

ITS CAUSES, SYMPTOMS, PATHOLOGY AND TREATMENT.

BY

ROBERTS BARTHOLOW, M.D., LL.D.,

EMERITUS PROFESSOR OF MATERIA MEDICA, GENERAL THERAPEUTICS AND HYGIENE IN THE JEFFERSON MEDICAL COLLEGE OF PHILADELPHIA; FELLOW OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA; MEMBER OF THE AMERICAN PHILOSOPHICAL SOCIETY; HONORARY MEMBER OF THE ROYAL MEDICAL SOCIETY OF EDINBURGH, AND OF THE SOCIÉTÉ MÉDICO-PRATIQUE DE PARIS, ETC., ETC.

AUTHOR OF A TREATISE ON THE PRACTICE OF MEDICINE, OF A TREATISE ON MATERIA MEDICA AND THERAPEUTICS; OF A MANUAL OF HYPODERMATIC MEDICATION; OF A MANUAL OF MEDICAL ELECTRICITY, ETC., ETC.

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PREFACE.

An enforced idleness of several months, the convalescent stage of a long and serious illness, I have employed in part in preparing this little volume at the suggestion of the Publishers. The literature of cholera is most voluminous, and the sources of information are immediately available, so that it were a comparatively easy task to make a big book. I have sought to make a practical book in the smallest compass, and to that end I have utilized my personal experiences in two epidemics of this disease, and have avoided historical accounts of successive outbreaks, and disquisitions on disputed etiological points. No extent of individual observations can take the place of the multiplied experiences, the far-reaching discoveries, and the amazing fertility of resource of modern medicine, however, and hence I have incorporated whatever is most noteworthy in the improvements made during the existing epidemic.

The management of the present epidemic as compared with former ones manifests a distinct tendency toward germicide, or antiseptic remedies, and is characterized by the introduction and general use of expedients of a surgical kind—such as enteroclysis, intra-venous transfusion, hypodermatoclysis, and subcutaneous injection. Whether the results are as successful as the devices are ingenious, may admit of question in the light of the mortality statistics. Judged dispassionately and all deductions allowed, it must be admitted, I think, that some progress has been made, and although the number of deaths in some localities may be equal to those in former epidemics, it yet appears certain that our therapeutical measures are attended with a constantly increasing improvement in the proportion of cures. Were it not so, I should hardly be justified in giving so much space, relatively, to the subject of the treatment of cholera as my readers will find that I have done.

R. B.

PHILADELPHIA, MAY, 1893.
1527 LOCUST STREET.

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CHOLERA.

CHAPTER I.

HISTORICAL INTRODUCTION.

DEFINITION.—By the term *cholera* is meant not a flow of bile, as etymologically it signifies, but an epidemic disease pursuing the lines of travel and commerce, specific in character, because due to the presence and development of a special micro-organism and appearing at certain intervals of time. It is often designated Asiatic, or Indian cholera, from the country of its origin.

Cholera morbus and *cholera nostras* are terms applied to a sporadic affection having similar symptoms but arising from ordinary causes, and only occasionally fatal.

Cholerine is an unscientific term, used to signify a mild form of cholera which it is supposed may develop into the genuine malady; but there is no case of cholera without the bacillus, and hence if this organism be present, cholerine (so called) is cholera

and nothing else. The term is used to allay the apprehensions of the timid, to prevent loss to business and commerce, and to save the community from that state of demoralization which is apt to ensue when a grave epidemic is admitted to exist by official or professional authority.

History.—It is not my purpose to write up the history of successive epidemics of cholera, but merely to indicate in outline the course pursued by the disease as a preliminary to the study of its etiology.

It is quite certain that in its epidemic form, proceeding from a centre or focus of infection to distant places, it is wholly modern. In the country of its origin it has been known from the remotest times. Its native home is the densely populated, malarial banks of the Ganges and Brahmaputra. Here the alluvial soil, the humidity, the isothermal lines, and the sanitary vices of an uncleanly and crowded population combine to form a suitable nidus for the germ of cholera. It was not, however, until 1817 that it began its epidemic march. Why the disease manifested a new activity at this period and changed from the local to the migratory character is not known, and the only plausible explanation is that which refers the transport of the germ to the agency of those Mohammedan fanatics who went on annual pilgrimages to Mecca. It was not, however, until 1827 that cholera invaded Persia and Arabia,

and to this period must be referred the beginning of those great waves of epidemic influence that presently swept around the world, although previously to this by ten years it had passed beyond India. In 1831 cholera appeared in Europe. In that year London was infected, and the disease was conveyed thence to Paris.

The continent of North America was invaded by the great epidemic wave of 1832. It first overflowed Canada, and in the cities of Montreal and Quebec raged with great violence; New York, Philadelphia, and other great centres of population being subsequently infected.

The epidemic of 1848, the next formal movement of the poison from east to west, began its preparations, so to speak, in 1846 when it ravaged the holy places of Arabia, Mecca, and Medina, then crowded with pilgrims. By the returning caravans, cholera reached Egypt and Asia Minor, Cairo suffering especially, and Constantinople became a centre of infection in 1847. Berlin was severely attacked in 1848; then Hamburg and London, and from London, as before, Paris received its infection, and was severely ravaged during 1849. To this country came the epidemic in 1849, the disease entering by way of New Orleans, thence spreading through the great interior valley by the Mississippi, Missouri, Illinois, and Ohio rivers. The epidemic influence persisted to a greater or less

extent until 1854, and was especially remembered for its destructive ravages amongst the overland emigrants to California from the time of its arrival in 1849 until its final disappearance in 1854-5. The epidemic of 1865-6 was far milder than its predecessors, but was, nevertheless, quite active amongst the Prussian and Austrian military forces then operating in Germany, and was comparatively severe in some of the cities of our interior continent, where the local and climatic conditions are not unlike those of India. For example, the epidemic was not without energy in the city of Cincinnati, where I then practised medicine. As physician-in-chief to the Municipal Hospital, then established to receive cholera patients, I had the best opportunity for observing the disease.

Since the epidemic of 1866, cholera has made one abortive attempt to develop a general susceptibility, and in various places there occurred local outbreaks, notably in the interior valley of this continent. At Cincinnati again, and other cities of the same region, some manifestations of infection were witnessed, but there was no general epidemic; but the cases, about the genuineness of which there could be no question, possessed the proper clinical characteristics. Since the first appearance of cholera in the great interior valley, sporadic cases and limited local epidemics having all the clinical features of cholera have

occurred from time to time. Are they examples of true cholera? Only a proper bacteriological investigation can settle this question; but my present belief is that the comma bacillus has become naturalized here under conditions so like those which obtain in its natural habitat, the valley of the Ganges, as to be able to maintain itself, if but feebly.

During the past year cholera has again appeared in Europe (1892), but has manifested a disposition to infest special localities rather than prevail in a general epidemic. Hamburg, Havre, Paris, Marseilles, Berlin, have been visited, and the first named with special virulence. It is a curious fact that no connection can be established between Hamburg and other points of infection. Nothing is known of the source of the first case that occurred in that city. The epidemic was very severe in Havre. The infection was supposed to be derived from the suburbs of Paris, but the immediate links in the chain of communication seem wanting. The first case occurred July 15th, the second July 28th, and the third August 3, 1892, when the disease was already in active epidemic form in Hamburg.

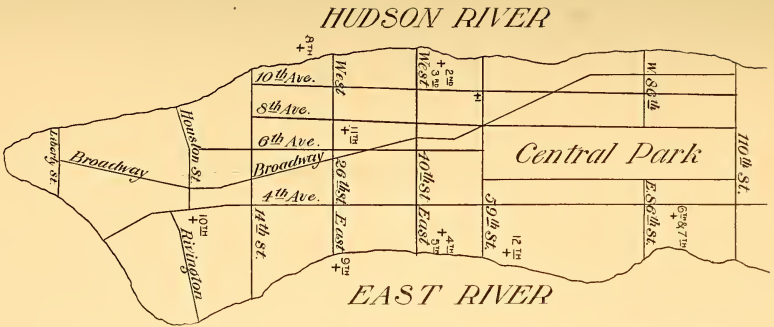
The arrival of vessels loaded with emigrants coming from infected ports to New York gave rise to most serious apprehensions throughout the United States. On the 30th of August the first vessel containing cholera aboard—the Moravia—arrived at

Quarantine, New York harbor.[1] There had been twenty-two deaths out of twenty-four cases of cholera on the passage from Hamburg to New York. Three days after the Moravia the Normannia and the Rugia arrived, both having cases of the so-called cholerine on board. In all, eleven vessels were detained at Quarantine, with cholera aboard or threatened. So carefully was the quarantine maintained, and so successful was the result, that not a single case penetrated the cordon to infect the inhabitants of the city. Notwithstanding this, eleven cases, as to the diagnosis of which there can be no doubt, occurred in isolated localities in New York City.[2] Not one of these had any connection or association of any kind with Quarantine; but one (No. 9) had any relations with the sea, and one was master of a canal boat. The fact that the cases had no topographical associations is clearly shown in the annexed diagram, for which I am indebted to Dr. Biggs's article just referred to. The single fact common to the cases that may have some etiological significance is that they were occupied in business connected with the supply of foods, especially with animal foods. Not one of them became a centre of infection for other cases. In all of those in which

[1] Wilcox: The Cholera of 1892 in New York. The American Journal of the Medical Sciences, Jauuary, 1893, p. 58.

[2] History of the Recent Outbreak of Cholera in New York, by Dr. Herman M. Biggs. The American Journal of the Medical Sciences, January, 1893.

FIG. 1.



Outline map of New York, showing topographical distribution of the cases of epidemic cholera.

Points marked + show where cases of cholera occurred, the numbers indicating the order of occurrence.

"8th" case: occurring in New York—a canal boatman.

"9th" case: a fireman from steamship "State of Nevada."

This map is so instructive from the etiological point of view that the space taken up by it is well appropriated.

the cholera spirillum was found—eight in number out of twenty-six suspicious cases—death ensued, and only one of those died in which the bacillus was not found.

"The first person affected with cholera in New York was taken ill the evening of September 5th, five days after the disease appeared in the harbor, and died September 7th." Dr. Biggs, in commenting on this remarkable behavior of cholera, says that "the high mortality in the recognized cases in the city and the lack of any association render two suppositions probable:

"*a.* That a number of mild cases of epidemic cholera occurred in which the nature of the disease was not recognized.

"*b.* That the cholera infection was in some way rather widely disseminated in the city."

When Hamburg was attacked with cholera no communication could be traced with any infected locality, although various parts of Russia and some of the ports of the Black Sea, as well as at Baku, were then in the throes of the epidemic. The infection could not be traced from London to Paris, which in the former epidemics had been the route of transmission. The history of cholera, therefore, contains some unexplained problems, and much remains to be done to put in a clearer light its mode of diffusion as observed in successive epidemics.

CHAPTER II.

ETIOLOGY: THE CAUSES OF CHOLERA.

In the study of the causes of cholera we discern two facts of supreme importance: the influence of bad hygiene—State, municipal, and personal; the existence of a special germ, a pathogenic micro-organism—the comma bacillus. It can be asserted with confidence that these two factors must be in operation to produce cholera.

The sanitary evils which prevail at the home of cholera and at those places where serious outbreaks have occurred in the course of epidemics illustrate the conditions necessary to its evolution. In India the overcrowding of the population, the filthy habitations, the insufficient food, the disregard of the most ordinary precautions for the disposal of excreta, the contamination of the Ganges river—the only source of water supply—with cholera stools or with the washing of cholera-stained bed-clothing, the alluvial soil, the damp atmosphere—all combine to form a nidus ever prepared and maintained for the nurture of the bacillus. Similar conditions are found

to exist wherever cholera has effected a lodgment. In no places outside of India have the various sanitary evils active in the production of epidemics been more rife than at the holy places of Arabia during the Mohammedan pilgrimages. An instructive narrative of these remarkable sanitary evils has lately been published by Dr. Sandwith, of Cairo.[1] He shows that in the last thirty-two years there have been sixteen severe epidemics of cholera in Arabia, affecting especially Mecca, Medina, and the other holy places, and the deaths have sometimes reached as high as five hundred every day from cholera alone. This tremendous mortality ceases to be surprising when the remarkably unsanitary state of the holy places is understood. During the pilgrimages of the faithful as many visitors crowd into the cities as the permanent population, which is itself more than sufficient to fill the available space. It is stated by Dr. Sandwith that as many as thirty adults are packed into a room only large enough for two or three even when closely placed. The heat is great, and the air is laden with dust and foul odors. The cesspools are never cleaned, and consequently the liquid part runs over into the streets, and more or less finds its way into the water reservoir. The water for the city of Mecca is drawn from the Ain Zebaida and is conducted to an open cistern, or pool, about three hundred feet in

[1] The New York Medical Journal, February, 1893.

diameter, and this must supply the population. The water becomes putrid with the decomposition of animal and vegetable matter, and has a nauseous taste. Thousands of cattle and sheep are sacrificed every day, and the blood and offal remain to decompose on the ground. All day the dirty, unkempt pilgrims crowd the Kaaba, and the air becomes unspeakably foul. When cholera is introduced the germs find ready access to the drinking-water and to the food, and hence very soon a large part of the population, already prepared for the reception and development of the germ, become infected, and the disease runs riot.

During the present epidemic several instructive examples of the influence of bad hygiene on the outbreak of cholera have been brought to light. I do not now allude to the epidemics that have prevailed in the unhealthy parts of cities, as Hamburg, Havre, Paris, Marseilles, but to certain strictly localized outbreaks, such as that at Nietleben Asylum, near Halle; at the asylum and prison of Nanterre, near Paris; and at Portal, near Boulogne, during last year's epidemic. The occupants of these asylums and prisons are subjected to certain special influences besides those that obtain in the district or community in which the institutions are situated; they are crowded and confined to close, ill-ventilated apartments; they have poor food, insufficient or no

exercise, and they experience much mental and moral depression and anxiety. Although the village of Nietleben and the city of Halle near by were free from cholera, the inmates of the asylum suffered severely. The water supply was derived from the same source, the river Saale. No explanation of the outbreak was forthcoming, and its spontaneous origin was being practically accepted when it was ascertained that an attendant had come from Hamburg during the time the epidemic was going on in that city, and it was further learned that some suspicious cases had happened in the asylum months before. So unfavorable were the local conditions at Nanterre that 95 per cent. of the cases of cholera died.

The epidemic at the small seaside town of Portal[1] was very severe; of 132 cases there were 76 deaths. Here there is every reason to suppose that the germs were introduced from Paris, there being constant and uninterrupted communication with Boulogne, of which Portal is a suburb. The water supply is derived from shallow wells. Some of the houses have cesspools discharging into the subsoil; some have pails which are emptied, when convenient, out into the streets or on some rubbish heap. That there should be an epidemic in Portal under these circumstances is not surprising.

Climate in itself has little influence over the

[1] Lancet, March 11, 1893, p. 550.

progress of cholera; it prevails under all possible conditions within the tropics, and within or near the arctic circle. Severe epidemics have occurred in St. Petersburg and more remote northern cities in midwinter. A humid state of the air as distinctly promotes as a dry state retards an epidemic. A moderate rain, a mist or fog, and a still atmosphere are favorable to the development of the germ, and often precede an outbreak of the disease. It is because of the dryness of the air and of the soil that pilgrims returning from Mecca by caravan through the desert are often freed from the cholera infection, so that the disease reaches Cairo but occasionally by this route.

Elevation retards the epidemic influence *en route*. It may leap over a lofty mountain chain, but it rarely prevails at an altitude greater than three thousand feet above the sea level. Yet in 1892 there was a formidable epidemic in the valley of Kashmir,[1] about 5200 feet above the sea level. The principal city, Srinagar, contains 125,000 people in "25,000 low, dirty houses, built irregularly on narrow lanes and alleys, which are used as latrines. There is no drainage, and the storm-water washes the filth and ordure into the Nalla Mar and into the river from which the drinking-water is obtained."

[1] The Cholera Epidemic in Kashmir, by A. Mitra. Quoted in the American Journal of the Medical Sciences, February, 1893, p. 232.

Cholera follows the lines of travel, and hence may proceed against or with the prevailing winds. It has often been observed that if the cholera poison diffuses with the air it should be carried in the direction of the winds, and that it is not so carried has always been an embarrassment to those who find in air currents the vehicle of its transport. In the same way, according to Pettenkofer, the "ground water" serves as a means of securing the dissemination of the poison. The Munich Professor has long maintained his theory, and still adheres to it, despite Koch's discovery of the comma bacillus. The surface water acts as a culture medium from his point of view. Much depends on the character of the soil. In a very dry, sandy soil the ground-water, to promote the development of cholera poison, must be comparatively high; in a damp alluvium the ground-water must be low to be effective. Low-lying places, valleys, malarious situations are favorable for the spread of cholera. It is thus that cholera selects its point of development, and though the germs may be diffused through a continent, they become active only in situations where the ground-water, the soil, the humidity, and the bad hygiene coincide to make a suitable home.

When cholera excreta are thrown upon the ground they soon pass into the surface water, and this becomes the vehicle for contamination of the drinking-

water. Cholera germs multiply rapidly in water, especially when it is contaminated with sewage.

Cholera is not contagious in the ordinary sense of that term. It is not directly communicable from one person to another, and it is not necessarily active even when the poison is swallowed. During the epidemic of 1866 at Cincinnati I was in charge of the cholera hospital, and made many autopsies, yet neither myself nor any member of my family had any symptoms of cholera infection. It has long been known that no risk attends the contact with bodies dead of cholera, but handling of the linen, clothing, bedding, and other objects about the patient is dangerous, especially the washing of the soiled sheets and clothing. The individual attacked with cholera must be in a receptive state; the intestinal canal must be prepared for the germ, but it is not necessary that the ground-water serve as a vehicle for the preservation and safe conduct of the germ. Hence it is that causes producing a catarrhal state of the intestinal mucous membrane favor the development of the bacillus—such causes as the eating of unripe fruit, and unhealthy and indigestible food of all kinds, and the drinking of beer and fermenting liquids and spirits. These may be exciting causes.

The male sex and occupation act as predisposing causes. Men are more exposed to the conditions favoring the reception and development of the germ,

but otherwise sex has no influence. Pregnancy is no bar to infection. Miscarriages occur, but, on the other hand, women go to full term and then die of cholera, an example of which I had at the cholera hospital; a woman was brought in from some hovel in a moribund state, apparently at the end of utero-gestation. Certain occupations appear to favor the reception and development of the bacillus, notably those concerned with food supplies, especially animal foods. This was the one fact of an etiological kind, besides the presence of the comma bacillus, ascertained of the cases in the city of New York; a majority of them were in some way connected with the preparation and sale of various kinds of foods.

Quite irrespective of the predisposing and exciting causes, above described, cases occur in every epidemic among those most favorably situated, amongst the well-to-do classes, admirably housed, and living under the best hygienic conditions. After an epidemic is well established and the material best fitted for the action of germs has been exhausted, the epidemic influence, unsatisfied, mounts higher and spreads more widely, and seizes in a strangely capricious manner its victims here and there; but these peculiarities are a necessary feature of a disease caused by an infection distributed through the drinking-water. The data proving the connection between outbreaks of cholera and the use of drinking-

water from special sources are very numerous and convincing. London epidemics have been remarkable for the variation in mortality when the local conditions were the same, except the supply of water. Of those districts receiving their drinking-water from the companies obtaining their supplies from the Thames river the deaths from cholera varied, according to the amount of sewage, from 8 to 163 per 10,000 of population. Again, during the epidemic of 1866 in London the mortality from cholera in the district supplied from the river Lea by the East London Company was 63 to 111 in 10,000 of population, whilst in the other parts of the city having an uncontaminated water supply the mortality was only 2 to 12 per 10,000. In 1854 a very severe epidemic of cholera broke out in Broad Street, in London, amongst the people using the water of a particular well, but the cases ceased when the well was closed. At Königsberg, in 1866, cholera was very severe amongst those making use of water from the river Pregel, whilst those obtaining their supply from a distant source, delivered through iron pipes, were but slightly affected. Facts of this kind have been frequently observed wherever cholera has existed: cesspools containing cholera dejecta, made to overflow by a sudden rainfall and their contents discharged into the neighboring wells, the water thus contaminated being made use of by the people of

a given area, amongst whom cholera has prevailed with great virulence.

The history of the epidemic as it developed in Hamburg seems conclusive as to the agency of the drinking-water. Cases occurred at widely separated points simultaneously at the beginning of the epidemic, and yet the limits of invasion were restricted within certain well-defined areas. The cities of Altona and Waldeck are adjacent to Hamburg and the same conditions of soil and climate obtain in all of them, but each one has its own supply of water. Hamburg is supplied by the river Elbe, just above the harbor, and the water is delivered unfiltered. It is well known that the ebb and flow of the tide reached up to the source of supply, and that the water was contaminated not only with sewage but with a multitude of organisms and other organic matter. Altona also, obtains its water-supply from the Elbe, but higher up; and beside, has long made use of a system of sand filtration which has proved rather effective. Waldeck is supplied from an inland sea. That these cities escaped and Hamburg was so severely attacked when all the local conditions were the same except the water supply, indicates that to the agency of the drinking-water must be referred the epidemic influence that pervaded the one whilst the others remained exempt.

At the recent conference on Cholera in the Russian

Empire, which met in St. Petersburg last December, it was shown that pollution of the drinking-water was in almost every case the channel by which the disease was spread. The epidemic of 1892 (last year) prevailed along the river courses—the Volga, the Don, the Dnieper, and others.

The following most instructive facts from the report of Dr. F. Clemow, on "Cholera in Russia,"[1] must also be mentioned: "In the village of Ulybyshef (Vladimir government) a laborer arrived on June 29th from Kazan, where he had attended the funeral of his brother who had died from cholera. Three days later he sickened with the disease in the morning, and died the same evening. The clothes he had worn remained in an out-building for a week. They were then washed in a stream from which the village drew its water supply. In a very short time cholera became epidemic throughout the village. In the government of Viatka five villages situated along the banks of the same stream were invaded by cholera. The infection was traced to the systematic washing of linen belonging to the early cases in the stream which provided the inhabitants of the five villages with their drinking water. No sooner was this practice forbidden than the epidemic began to abate. In the village of Upper Moulla (Permskoy government) the

[1] The Lancet, London, May 6, 1893.

linen of cholera patients was washed in a pond. From the same pond the inhabitants drew their supply of drinking-water, with the result that cholera raged throughout the village. . . . As soon as the washing of linen in the pond was put a stop to, the number of cases of cholera began to diminish."

Again—"In Great Bereznikof, a village in the Simbirsk government . . . cholera attacked only that part of the village which drew its water supply from the river Kshi, whilst amongst the inhabitants of the other half of the village, whose drinking-water was derived from wells, there was but a single case—that of a beggar woman to whom some clothing from an infected house was given." Other instances of the same kind appear in this report. "In two villages of the Tambof government . . . cholera was confined to the inhabitants drawing their water supply from a pond contaminated by washing in it the linen of cholera patients, whilst those supplied by well-water not so contaminated did not have a single case of cholera!" I might adduce various examples of the same kind from this report, but these must suffice. It is only in a country like Russia that instances of this kind can be so successfuly traced out, although every epidemic in all parts of the world, some of which have been already referred to, furnish us with illustrative facts showing the agency of

drinking-water as a means of communicating the cholera infection.

The weight of evidence is, therefore, clearly in favor of that view of the diffusion of cholera by drinking-water, which is now generally held; but not all outbreaks are referable to this cause, for, as the facts at New York indicate, the occupation of the individual attacked seemed in some way, not now explicable, responsible for these seizures.

None of the causes of cholera herein described, nor any combination of them, can really produce the disease in the absence of the specific germ. Pettenkofer, the distinguished Munich sanitarian, maintains that three several conditions must coincide to produce a cholera outbreak, and these he represents by the algebraic signs x, y, z. If x stands for the poison or germ, y for the climatic state, the soil, and surface water, z will represent the state of the individual. If one of these be wanting there can be no cholera. As has been intimated, with Pettenkofer the soil with its ground-water is a kind of culture-field where the cholera poison must undergo preparation for activity. Professor Arndt, of Griefswald, who has studied the explosive outbreaks at Nietleben Asylum and at Nanterre, and could not trace the introduction of the poison from without, came to the conclusion that it was "home-grown"—an example of spontaneous generation, it might be supposed, but really an

exaltation of the virus by successive cultures in the local media of filth. Professor Peter maintains the spontaneous origin of the cholera virus under the circumstances of crowding, impure water, foul air, unhealthy habitation, bad food, etc.[1] Other bacilli —for example, the spirillum of Finkler—it is possible, may, by spontaneous changes in the media about them, develop into the pathogenic forms.

The agency of living organisms has long been invoked to account for the propagation of cholera, and every epidemic has witnessed the discovery of an organism supposed to have pathogenic relation to the disease. It was not possible to differentiate the various forms found in the cholera dejecta until the means of culture and staining, followed by experiments on animals, came to be understood. It was reserved for Koch to demonstrate the micro-organism of cholera. Sent out, in 1884, to India at the head of a commission to study cholera in its home, Koch soon differentiated the form now to be known as the *comma bacillus*. At first his statements were received with some incredulity, but the recent studies at Hamburg, at the Moabit Hospital in Berlin, at New York, and elsewhere, have fully confirmed his conclusions at all points. The doubts entertained at first with regard to the comma bacillus arose from the circumstance that the

[1] Lancet, March 4, 1893, p. 49.

inferior animals are not, as a rule, affected in a way to justify the opinions of its toxic powers; but with proper care and by introducing the cultures into the intestinal canal, mice and guinea-pigs have been characteristically affected, and what is more significant, the human subject, in the notable cases of Pettenkofer, Emmerich, Hasserlik, and some others, having been experimentally acted on by the direct introduction of the germs by swallowing, afforded the clearest evidence of a toxic action. That a given organism be considered specific it must fulfil these conditions: It must always be present in the disease in question; it must be cultivated in suitable media and separated from all other forms; in its growth and development in these media and apart from the body it must always conform to the original type; when these cultures are introduced into the bodies of animals susceptible to their action they must cause a disturbance like the original malady in respect to the symptoms and changes of structure; the parasites must be found again multiplying in the secondary subject. These conditions complied with, there can be no doubt that such germs are specific and pathogenic.

The spirillum of cholera was designated by Koch as the *comma bacillus*, because of its resemblance to the comma (,) of written and printed language. It has an arc-like body, slightly twisted on itself,

FIG. 2.

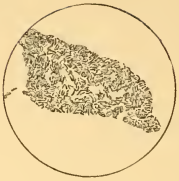
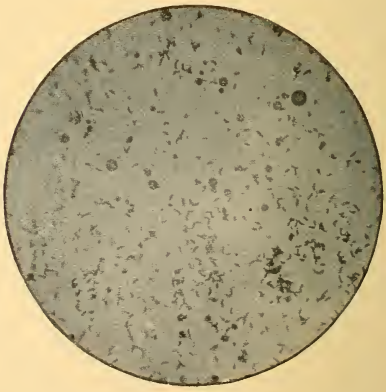


FIG. 3.

In Fig. 2 we have a representation of the spirillum, unstained, in a cover-glass preparation. In Fig. 3 the bacilli are more distinct and separate, and were in the original stained.

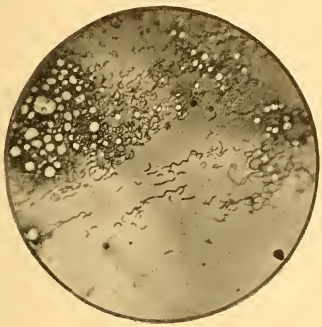
FIG. 4.



From DR. DUNHAM'S paper "On the Bacteriological Examination of the Cases of Cholera in New York."

spiral, rounded at one extremity, and contains at the end flagella. It is motile and about half the size of the bacillus tuberculosis. It is anaerobic, that is, thrives best without oxygen, but it can live in the presence of oxygen. The comma bacillus grows

FIG. 5.



From DR. DUNHAM'S paper.

Figs. 4 and 5 are cover-glass preparations under a much higher power—700 diameters. These figures are copied from photomicrographs. Of course, the bacilli must be carefully distinguished from the matters in which they are imbedded, and from air bubbles. Compare the forms in Fig. 3 with the same to be seen in Figs. 4 and 5.

readily in various nutrient media having an alkaline reaction, and can be cultivated easily. It takes the aniline stains, and is colored with fuchsine solution. It liquefies gelatin. Such are the main character-

istics of the micro-organism of cholera.[1] In Figs. 2, 3, 4, and 5 we have a representation of the bacillus as seen in cover-glass preparations, for which I am indebted to the article of Dr. Dunham, of New York, except Fig. 3, which, with Fig. 6, is from Koch.

Fig. 6.

The bacillus in cholera dejections on a sheet. (From Koch.)

The cholera bacillus is contained in the dejections of a cholera subject—in the matters vomited and passed by stool—the so-called rice-water discharges. These thrown out on the ground where there are human habitations find access to the wells and springs, and to water-courses, and thus in drinking water are disseminated. In high northern latitudes

[1] Grundriss der Bakterienkunde. Von Prof. Dr. Carl Frankel. Dritte Auflage. Berlin, 1890.

the cholera dejecta thrown out on the snow soon reach the intestinal canal of man, because melted snow is used for drinking-water and culinary operations. Hence it is that cholera seizes so many and is so destructive in the far north when an epidemic is prevailing. Cold merely inhibits the parasite but does not destroy its vitality. It has been shown that the bacillus flourishes in water containing organic matter and alkaline from the presence of ammonia. It is not known how long it will preserve its vitality in the water of running streams.

We have some carefully conducted experiments to illustrate the viability of the cholera bacillus when attached to various articles. Uffelmann,[1] in a recent paper, has shown that the bacillus on the surface of rye bread open to the air remained alive for twenty-four hours, but when the bread was wrapped in paper it continued viable for three days. On roasted meat, placed under a bell jar, the spirillum was active at the end of a week; on the printed page seventeen hours; on writing-paper in an envelope twenty-four hours; on the hand, somewhat more than an hour; on silver and copper coins, a half hour only; on textile fabrics, in a dry state, four days, but when moist they continued viable more

[1] Berliner klin. Wochenschr., 1892, No. 48. Quoted by Sternberg—The Practitioner, March, 1893, p. 235. Also, The American Journal of the Medical Sciences, March, 1893, p. 357.

than twelve days. The observations published by the Imperial Board of Health, of Germany, on this subject are very important. It was ascertained that the bacillus was active when on fresh fish about two days; on salted and smoked herring only one day; on sweet cherries three to seven days, sour cherries, three hours; strawberries, one day; on pears two to five days; cucumbers, five to seven days; on dried fruits one or two days. As regards fluids, the germs were active as follows: In beer for three hours; white wine, five minutes; red wine, fifteen minutes; cider, twenty minutes; cold coffee, two hours; milk, not sterilized, twenty-four hours, and milk sterilized, still living at the end of nine days; tea, two per cent. infusion, four days. From such data we readily see how the germs of cholera can be conveyed. The poison may be carried by the non-infected to others who have become susceptible without experiencing the action of the poison. The intermediary may unload his burden of infectious material at a long distance from the point where it was taken up, and thus the source whence the infection was derived remains unknown. By the potable waters of rivers, by paper money, by various foods, and similar accidents, contamination may be effected and all intermediary agencies remain unknown. The house-fly should not be overlooked—for Uffelmann found that two hours after walking through

cholera dejecta flies could infect nutrient media. It follows from these facts that the most mysterious and apparently inexplicable outbreaks are still capable of explanation.

It is not alone necessary that the comma bacillus be present for an attack of cholera to occur. Individual susceptibility must coexist, and the spirillum must gain access to that part of the body where a suitable nidus is formed for its growth and development. That part is the intestinal canal of man. No other part of the body furnishes the necessary conditions, and even this part proves inhospitable unless some preparatory changes have taken place to render it a suitable nidus. It is in respect to this that such etiological factors as improper food, spirit and beer drinking, exposure to cold and dampness, and other factors promoting a catarrhal process and an alkaline reaction prepare the way for the reception of the germ and its pullulation. It can hardly be doubted that the germ must reach the intestinal canal. If breathed with the air it must lodge in the mouth or fauces and be swallowed; if contained on the hands or under the finger nails it must attach itself to some articles of food; if paper money be soiled with it, or articles of clothing, they must impart their infection to the food or drink. All the facts tend to show that the drinking-water is the most important vehicle for conveying the poison to the intestinal

canal of man. That the spirillum is found with difficulty and in relatively small proportion in the waters of rivers and running streams does not alter the great fact.

I must not fail to describe with more particularity as respects the agency of the spirillum in the production of cholera, the striking experimental data in the voluntary infection of Hasserlik and four others of Vienna, and of Profs. Pettenkofer and Emmerich, of Munich. We have exact particulars of the experiments as carried out by the Munich professors. Pettenkofer swallowed one cubic centimeter of fresh bouillon culture of the bacillus, and, to obviate the action of the acid gastric juice, took at the same time one gramme of sodium bicarbonate. Diarrhœa commenced in thirty hours and lasted eight days. By the second day of the diarrhœa the stools had become almost colorless, but there was no nausea and the diet was continued unrestricted. There was a good deal of rumbling in the bowels and occasionally an imperious inclination to stool. Pettenkofer continued at his usual occupations and experienced no abatement of his bodily vigor.

Emmerich repeated the same experiment, but in his case the results were more decided. The stools had at one time a distinctly rice-water character and there was considerable prostration. The

bacilli were found in large numbers in the stools of both experimenters.

Pettenkofer does not admit the specific action of the comma bacillus in these experiments; but unprejudiced observers can hardly come to any other conclusion. Guttmann,[1] in commenting on these experiments, holds that they clearly indicate the specific character of the bacillus and that Emmerich had a mild attack of cholera and Pettenkofer of choleraic diarrhœa. Posner,[2] of Berlin, also takes the same grounds, and maintains that the results of the experiments are conclusive of the toxic action of the germs. That not more severe results ensued in these cases was because they were not in a susceptible state, and that the gastric juice was not sufficiently neutralized. It has been suggested and is highly probable that the virulence of the bacilli had been lessened by repeated cultivation—a fact now known to be true. The germs swallowed by Pettenkofer had been sent to him from Hamburg, and were subsequently cultivated in bouillon, and, hence, it may be that the virulence of the toxine had been reduced by these manipulations. Furthermore, it is generally understood that a predisposition to the action of the bacillus must be created; the way must

[1] Deutsch. klin. Wochenschrift, No. 47, 1892. Quoted in the Practitioner and in the American Journal of the Medical Sciences, March, 1893.

[2] The Practitioner, ibid.

be prepared for the reception of the germ, and the conditions necessary for its growth and development must be arranged in advance. These experimentalists suffered quite as severely from the taking of the germs as might *a priori* have been expected, and only the most prejudiced minds can fail to see the relation between the swallowing of the germs and the considerable intestinal disturbance that followed in every case.

CHAPTER III.

THE SYMPTOMS OF CHOLERA.

The symptoms of cholera are naturally divisible into four groups:

1. The Prodromal or Diarrhœal Stage;
2. The Systemic Infection;
3. The Algid Period;
4. Reaction, or The Typhoid Stage.

1. When an outbreak of cholera is about to appear, a general tendency to relaxation of the bowels is sometimes manifest, or cases of diarrhœa are more common, or slight errors of diet more easily than is usual, cause intestinal irritation. This general state may be likened to the "epidemic constitution" of Hippocrates; it indicates the existence of a special susceptibility; it seems to imply that a universal though occult cause is in operation. In view of what is now known of a cholera germ, it may be assumed that it is beginning its active life, not yet attaining to its highest powers, but growing on the surface of the mucous membrane, and thus exciting a disturbance—an intestinal catarrh of limited extent, but not a

fully developed seizure. After the first few mild cases of an opening epidemic, the most severe cases occur at the beginning, and as the epidemic influence declines the susceptibility lessens, and the severer types cease to appear.

Although it is usual and correct enough to say that a tendency to diarrhœa is the first real manifestation of a cholera seizure, yet close inquiry will usually develop the fact that some vague sensations of depression, of chilliness, of weakness, precede the diarrhœa. Some uneasiness is felt about the umbilicus, there is rumbling in the bowels, and a sense of relaxation is experienced. It often happens that without any warning a large watery stool is evacuated, and the diarrhœa sets in with sudden violence. No pain is felt with the stools, rather relief to a sense of distention, and the fluid evacuation pours out noisily; it is thin, light in color, yeasty in appearance and has a mouse-like odor. In old subjects the discharges may be tinged with blood, or at any age they may have a faint greenish tint or brownish, but usually they soon become whey-like or rice-water-like and contain whitish flocculi and masses of yeasty-looking material floating about or settling on the sides and bottom of the close stool. The call to stool is usually sudden—so sudden that often the clothing and the bedding are stained from inability to control the sphincter. The discharges are composed of blood-

serum, intestinal epithelium, urea crystals of triple phosphate and ammonium carbonate, and the reaction is alkaline as a rule, although it may be neutral. Numerous organisms are found, as also the indispensable comma bacillus. The number of bacilli is not a necessary indication of the severity of the seizure, for the attack may be a mild one when there are large colonies present, and a severe one when there are but few; nevertheless the rule is that the number and activity of the parasites afford a measure of the violence of the disease. The diarrhœa is apt to come on after midnight—after some hours of unquiet sleep, or toward the early morning, and a few violently explosive discharges copious in quantity usher in the algid state. Or, beginning in the after part of the night, the diarrhœa persists during the day, the stools gradually assuming the characteristic appearances, becoming light in color, then whitish, more fluid, yeast-like, more alkaline in reaction—more distinctly the real rice-water evacuation, as the day wears on. In some instances the diarrhœa goes on in the manner of an ordinary diarrhœa, and then suddenly assumes the characteristic form, becomes copious, watery, rice-water-like, and almost immediately the patient passes into the algid state. Vomiting, with little or no nausea, and hardly more than merely the act of regurgitation, appears at varying times during the diarrhœal stage, usually, of course, at the ap-

proach of systemic infection. If treated at an early period, the diarrhœa is usually arrested, and hence must remain the doubt, in the absence of a bacteriological examination, whether the case is one of true cholera. When an epidemic of cholera is at its maximum of activity, the diarrhœa manifests a less manageable disposition. Although painless, the discharges are noisy, explosive, and little modified, if any, by the measures employed, and certainly not stopped in the gravest cases. The circumstances influencing the violence of the cholera diarrhœa are probably more the condition of the individual attacked and his immediate surroundings, than the state of the germ. When improper food has set up an active intestinal catarrh, or other causes have been in operation to bring about the same kind of disturbance, we may suppose, by way of example, that the bacillus finds in this state a suitable culture field for its growth and development, and is hence less amenable to treatment.

2. *The Systemic Infection.* No well-marked boundary separates the prodromal from the infection stage. Usually some chilliness and a general malaise, not very well defined, are experienced. Some weakness is felt, nausea comes on and with little warning vomiting occurs. Like the stools, the vomit comes up easily, quickly, and with little preliminary disturbance. First, any food present is brought up, then

mucous and bilious matter, and very soon—usually, indeed, at the second vomiting—a quantity of whey-like fluid, the rice-water matter, comes boiling up by an act rather of regurgitation than of strenuous vomiting. Like that passed by the bowels, the matter regurgitated from the stomach is alkaline in reaction, and is composed of the serum of the blood, epithelium in great quantity, phosphate salts, carbonate of ammonia, urea, and numerous organisms, amongst which are found the spirillum of cholera. The tongue is cool, sticky, and the mucous membrane covered with a whitish layer of the cast-off epithelium. There is much thirst, and the water drunk is quickly brought up again.

There is now a general depression of the forces; the patient feels weak and unequal to effort, the pulse is weak and rather quick than slow, the tension somewhat unequal. The urine becomes scanty, and then none is passed, and when the catheter is used but little, if any, is brought away. The urine at an early period contains albumin, tube-casts of a granular character, and a great deal of epithelium and carbonate of lime, but the urea is comparatively small in quantity. Most patients become apathetic, indifferent, and lie in a somewhat somnolent state, eyes half closed; others are restless, sighing and tossing rather wildly about the bed, and full of the horror of the situation. The respiration declines in force and vol-

ume, and varies in rhythm, having a rather sighing character. The expired air is cool. The voice becomes husky and distant; the countenance is dull and dusky in hue; the face is beginning to shrink, the eyes to become retracted.

Thus far but little distress except the feeling of weakness, and some intestinal uneasiness, are experienced, but with the stage of infection muscular cramps occur first, and chiefly in the muscles of the calf, then in the arm, and at length in the voluntary muscles generally, even the muscles of the larynx, of the ear, and occasionally the intestinal muscular layer being attacked. When the cramps are severe, the muscles are drawn up into hard knots, and cause intense pain, so that the patients shriek out in their agony. I have often heard these cries in the night as I have passed along the street on my way to the bedsides of others sick with the disease, during the epidemic of 1866. As the muscles contract with the cramp, the action of the heart gets slower and weaker, and for a time the pulse may disappear. These cramps are, in part, due to the extreme loss of fluid, and to anæmia of the muscles, but chiefly due, as I think, to the action of the cholera toxine on the medulla oblongata.

3. *The Algid Stage.* The profuse watery evacuations, the loss of serum from the veins, the desquamation of the epithelium, cause rapid failure in the

vital resources. The pulse at the wrist, at first unequal in tension and fluctuating in force, declines in strength and volume until at length only a faint vibratory trembling can be felt, or it ceases altogether. The sounds of the heart are barely audible, and the apex beat makes no impression on the chest-wall. The countenance is bluish or cyanosed, retracted and shrunken; the lips drawn back, exposing the teeth; the eyes deeply sunken in the orbits and surrounded by dark circles; the vision is dim, the pupils contracted; conjunctivæ injected; the voice is a mere husky whisper, and a pause is needed between every word to gather the strength required to utter the sound—*vox cholerica*—the hearing is dull and there is singing in the ears, the external ear is of a bluish, or brownish-purple tint; the breath is cold, and the movement of respiration is slow, shallow and sighing; the surface of the body is cold, the skin shrunken, and sodden like the hands of a washerwoman; the face, neck and extremities, both upper and lower, are more or less deeply cyanotic, the toes and fingers incurved, retracted, and rigid with cramp —such is the complex of symptoms of the algid stage as ordinarily witnessed.

The coldness of the surface is represented, of course, in the lower range of the thermometer, but not wholly so. The surface is cold to the touch, when the actual body heat, as shown by the thermom-

eter, is not much, if any, below the normal, and not sensibly much colder when the temperature is registered as low as 92° F. The usual thermometric range is from normal to 94° F., but the body temperature has been known to fall as low as 88° F. in the axilla, and a few instances have been reported in which it is said to have descended as low as 82° F. The rectal temperature is higher than the surface temperature, and its range between extremes is less extensive. The loss of the blood-serum and the damage to the red blood globules, limit or suspend oxidation, and the outward diffusion from the veins increases heat dissipation. Hence it is that the patient in the algid stage grows cold as a frog, becomes apathetic and indifferent to his fate, somnolent or stupid, or actually passes into a comatose condition. Although lying thus in the lowest state compatible with existence, sometimes his muscular strength is preserved in a marvellous degree. Without pulse at the wrist, patients have been known to get up unexpectedly and wander about, and some in bed alongside of each other have been heard to make bets regarding the distance to which they could eject the vomit, and on the dexterity with which they could deposit it in a given receptacle. It is probable that such patients had not reached the lowest algid state.

There are cases that pass at once into collapse without any preliminary vomiting or purging; they are

stricken suddenly, and fall down where they happen to be with retracted features, cold surface and cyanotic, an exceedingly weak pulse, slow and sighing respiration, and the usual muscular cramps. In such cases the abdomen is full and rather prominent, there is a distressing sense of distention, but no escape of rice-water matter occurs by vomit or stool. Hence such cases are designated *cholera sicca*, or the dry cholera. The diffusion from the veins and the desquamation of the intestinal epithelium have occurred just as in other cases, but owing to a paretic state of the muscular layer of the bowel, the contents of the canal are not expelled, but remain. These cases are, in fact, of a severe type, as a rule, and profound intoxication occurs, because of the increased absorption of the toxine, which is, also, we may suppose, produced in greater quantity. In the epidemic of 1886, a case of this fulminant form came under my observation, of a young lady in a well-to-do household in a large roomy mansion, in no way connected with the localities in which cholera had been occurring. She was taken whilst sitting in the parlor conversing with some friends, with sudden faintness, was carried to bed in a half-comatose state, and died within four hours after the first feeling of weakness came on. In other fulminant cases the patient lapses into coma and insensibility after one or two discharges by vomit and stool. In still other cases, a diarrhœa had

lasted for a day or two, but because painless, and the movements occurring at considerable intervals, it was not heeded, and the onset of the disease was referred to the profuse and tempestuous dejections ushering in the algid state; but these are not properly examples of the fulminant form.

In a considerable proportion of cases the vomiting and purging cease when the algid condition is fully established, or the vomiting ceases, and only an occasional stool occurs; but it is soon found that no change has taken place in the other symptoms except that they are more severe; no urine is secreted; the pulse does not return to the wrist; there is increasing hebetude of mind, an actual asphyxia supervenes. If under such circumstances the vomiting and purging cease, only unfavorable conclusions must be drawn from this occurrence.

4. *Reaction Stage.* Cases in the algid state that proceed to recovery—certainly not a large proportion —may simply convalesce, and in two or three days get well. Others pass into a typhoid state, and with the symptoms of uræmia linger for several days, at last dying comatose. Still others continue with the symptoms of diarrhœa or of dysentery, for a week or more, dying at last, or slowly recovering.

Reaction may set in from the low state in which life can hardly be said to exist; the breathing which had been shallow, sighing, and at long intervals,

gradually gains in depth and force; the pulse which may have been absent from the wrist begins to be felt again as a merely vibratory trembling under the finger; the shrunken face and dusky countenance freshen up a little; the eyes which were glazed and dull become more animated in expression; the tongue which had become dry and brownish in color along its margins, now moistens, and the voice announces its return to use by a hoarse whisper. With the returning circulation the temperature rises again, approaches the normal and even passes above. In the most favorable cases convalescence is established, the urine is again secreted and in increasing quantity, whilst the albumin lessens and presently ceases to appear; the stools become colored again, bilious in aspect, and although thin at first, soon become properly consistent as digestion is resumed. The vomiting stops finally; some appetite now takes the place of an intense and insatiable thirst; and with suitable food blood-making is actively resumed, and the strength restored. Such is the course when reaction occurs and convalescence is fully established.

As already intimated, such a favorable course is not common. The physical law holds good here, as elsewhere—to every action there is an exact and equal reaction. When, therefore, the cholera subject is carried down into the lowest depths of the algid stage, the return must be by correspondingly severe and

difficult methods. The reaction is often incomplete. The functions are re-established in part only; the bowels continue relaxed, and the stools assume a brownish tint, and have an odor of decomposition; the secretion of urine is insufficient and it continues albuminous; the abdomen becomes distended, and gurgling in the right iliac fossa can be evoked by pressure as well as some tenderness. In other cases, besides a simple diarrhœa a dysenteric state is superadded and rectal uneasiness with tenesmus are felt, with the distress belonging to ileocolitis; the stools are rather large, offensive, and contain a good deal of mucus with some blood. So far as the intestinal canal is concerned, there are, therefore, two kinds of reaction symptoms—diarrhœal and dysenteric; but there is probably no case in which dysentery alone is present. The surface of the body is no longer cold, and the temperature rises into the febrile, with morning remission and evening exacerbation. The mind is no longer merely apathetic, or occupied with vague terrors, but there is drowsiness, if not actual stupor, and some muttering delirium, picking at the bedclothes and subsultus tendinum, or a condition of coma vigil comes on.

Such is the symptom complex which presents itself in the typhoid stage of cholera. If symptoms, such as headache, coma, twitching of the muscles, and especially if convulsive phenomena ensue, and the

urine is especially meagre, or wanting, the case is one of the uræmic form.

During the algid stage, and especially during the period of reaction, various eruptions appear on the skin. More frequently than any other it has a measles-like form, is punctated, discrete, and reddish-brown in color. It is more abundant about the forehead, the eyelids, and the forearms, than elsewhere. It is sometimes urticaria-like, and rarely has the appearance of erythema nodosum. The punctations of the measles-like eruption, as seen on the abdomen during the typhoid stage, present a superficial resemblance to the typhoid eruption.

CHAPTER IV.

PATHOLOGY AND MORBID ANATOMY OF CHOLERA.

IMMEDIATELY after death the temperature of the body may rise several degrees above the normal. After the subsidence of the body heat, the post-mortem rigidity sets in promptly. In all cases the muscular rigidity is considerable, not unlike that of tetanus, and persists for several hours; the hands and feet are incurved, and the joints stiff to immobility unless some force be used. The neck and face still exhibit the cyanosis and venous stasis which are such marked features during life, but they are now supplemented and intensified by the post-mortem congestion. The face is shrunken and dusky; the eyes are deeply sunken and still surrounded by a dark areola; the mouth is retracted and the lips fixed in a *risus sardonicus*, and the teeth, covered with sordes, are exposed. The abdomen is prominent or retracted; when there has been neither vomiting nor purging, prominent; but when the contents of the canal have been freely discharged, the abdomen is retracted.

The tissues are generally dry, the veins collapsed except those of the intestine, and the body throughout is exsanguine. The intestines have, as a rule, a uniform rosy tint; the peritoneum is dry and sticky, the folds of the intestine adherent, but there is no inflammatory exudation to bind them together. If the intestines are "stripped" between the thumb and fingers from above downward, a quantity of fluid and semi-fluid whitish rice-water matter can be forced out, and is found to consist almost wholly of the intestinal epithelium, with many micro-organisms, including the bacillus. The solitary glands of the mucous membrane, throughout the whole tract, are enlarged, but peculiar appearances are found in the small intestines. The veins of the ileum are prominent, the solitary glands, the patches, the follicles, are swollen and prominent, and the "shaven-beard" appearance is very marked in places, more especially in the case of those subjects dying during the reaction or typhoid stage. The longer the case continues after the algid stage, the more pronounced the changes, in their completest development consisting of oblong patches of thickened glands studded between with black points, the orifices of Lieberkuhn's follicles, whence the homely designation of *shaven-beard appearance.* The epithelium of the mucous membrane, notably the columnar epithelium of the villi, if not detached, leaving the basement membrane

bare, is more or less advanced in fatty degeneration, and loosening, and the villi are often in a state of necrosis. This condition of the epithelium was a constant phenomenon in former epidemics, and was noted in the intestinal canal after death, as in the dejecta passed during the progress of the case. During the late epidemic in Hamburg, at Berlin (the Moabit Hospital) and elsewhere this state of the epithelium was also observed. The comma bacillus penetrates into the villi, and into the follicles of Lieberkuhn, and where an ulcerated surface gives them an entrance, into the deeper tissues; but they are not found in the blood, nor in any organ or part outside of the intestinal canal. They do not persist throughout the whole course of every case; in some they disappear early, and in others are not encountered after the twentieth day.

The liver besides an excess of black blood exhibits no special change, except the desquamation of the epithelium lining the ducts. In 1866 I found the gall-bladder distended with bile, but there was no bile-staining of the common duct. The spleen has been represented in two conditions; as enlarged and flaccid, as firm and small or normal—the former being found when the case had continued on to a typhoid or uræmic stage.

The heart muscle is usually well contracted and the cavities empty, or they contain some rather dark

clots in the case of early fatal termination; it is flaccid, and its substance easily torn, in the cases fatal after a more or less prolonged typhoid stage. Some fluid black blood, or some loose tarry clots, are sometimes found in the right cavity only. The pericardium has the same dry state and the same adhesiveness as the peritoneum. The pleura is also sticky and dry, the surfaces adhering. The lungs are dry, exsanguined, and collapsed, but no special lesions occur in these organs.

Besides the fulness of the veins of the meninges, and the characteristic dryness, there are no changes in the brain proper. A very evident hyperæmia of the medulla oblongata I observed to be a constant phenomenon in the epidemic of 1866, and there seemed to be a certain proportion between this congestion of the medulla and the muscular cramps. The explanation of this is not far to seek. The cholera toxine, we may suppose, has a selective action on this part of the nervous system, as strychnine or conine. The germs themselves do not get beyond the intestinal canal, but the toxine they elaborate is absorbed, and reaches distant parts for which it may have a special affinity.

The kidneys exhibit characteristic alterations. They are rather large and flabby, of a faint reddish tint or white and smooth. The epithelium of the tubules is affected with "cloudy swelling" and

undergoes fatty degeneration; it is loose and desquamating or readily detached. Little or no urine is found in the bladder; any present contains albumin, abundance of epithelium, casts, much lime salts, etc. According to Reiche[1] hemorrhagic infarctions are found in the endometrium in 65 per cent. of the cases of adult women, and hemorrhage into the stroma of the ovaries is, also, not uncommon; but these changes can have no relation to the disease as it manifests itself during the life of the patient, nor are they essential elements in the morbid complex.

From the data now before us it is possible to construct a consistent theory of the pathology of cholera. In some manner, whether by the agency of food or drink, or by other vehicle of infection, the comma bacillus finds its way into the intestinal canal of man. If the mucous membrane is in a receptive state, if there be present no hostile organisms—no phagocytes—to destroy the bacillus, it lodges, undergoes development, produces its own kind, and also manufactures a toxine—an organic poison—that being absorbed affects the system at large. The local irritation of the mucous membrane caused by improper food, by alkaline fermentation, by alcoholic drinks, etc., prepares the way for the spirillum, makes easy its growth and pullulation, and so changes the local

[1] The Cholera in Hamburg: Dr. Reiche. The American Journal of the Medical Sciences, February, 1893. Translated by Dr. A. A. Eshner.

conditions that the diffusion of liquids is from the vessels outward into the canal, instead of inward from the intestines into the bloodvessels. In the midst of these favoring circumstances the spirillum multiplies exceedingly—they penetrate into the follicles, into the epithelium of the villi, and more deeply into the tissues should an ulceration offer the means of so introducing them. How much the mere growth of the bacillus contributes to the changed physical condition, causing diffusion of the blood serum outwardly, or how much may be due to the toxine after its absorption, is impossible to say. The great outpouring of fluid, and the enormous discharge of the rice-water matter, must necessarily lessen the fluidity of the blood, make it rather viscid, and difficult to move in the vessels. The shrunken condition of the body, the low temperature, the muscular cramps, the anuria, are all consequences of the great loss of fluid from the vessels, and are partly, it may be, due to the action of the toxine, but the enormous diffusion from the veins is adequate to the production of these signs and symptoms.

The return from the algid stage is a necessary *reaction*, if life continues. Secretion of the gastro-intestinal juices, of the bile and pancreatic fluid, and of the urine, must then take place, and convalescence be established. If the reaction is imperfect and too much damage has been done to the organs, there is

an incomplete resumption of function. This imperfect performance of some necessary functions constitutes the morbid complexus known as the typhoid state.

COURSE, DURATION AND TERMINATION.

The limits of the prodromal stage of cholera—the period from the first infection to the beginning of objective symptoms—are by no means well established. It is usually stated as about three days. As the onset of symptoms means such development of the spirillum colonies as to cause irritation of the mucous membrane, there must be some variation in the time required in different subjects and under the changing conditions in each. All the circumstances that favor intestinal derangement promote the reception and growth of the bacillus, and *vice versa*. It is obviously difficult to fix upon any time. To say when the germ was swallowed, and when the first uneasiness was felt in the abdomen, is not possible, except in such experimental trials as those lately made in Vienna and Munich. Pettenkofer swallowed on October 7, 1892, one cubic centimetre of a fresh bouillon cholera culture; on October 9th, or some forty-eight hours after taking the germs, he had the first symptoms of intestinal irritation—borborygmi and six to eight liquid motions. In Emmerich's

case the incubation period was shorter, probably because the culture he took was only twenty-four hours old, whereas Pettenkofer's specimen had been received from Hamburg, and from this again cultures were made, thus reducing the toxic power of the spirillum. Emmerich swallowed the germs on October 17th, and the same night he had some irritation of the intestines and several liquid stools, which continuing, on the 18th and 19th he had characteristic rice-water discharges. In all, he passed twenty to thirty rice-water stools, and suffered from intense thirst, colic, prostration, and loss of voice.[1]

Hasserlik and four others in Stricker's Institute of Experimental Pathology, swallowed doses of comma bacilli. In from thirty-six hours to five days they experienced intestinal irritation in varying degree.[2] These data show conclusively that the period of incubation varies, that if a given number of patients receive the poison at the same time, they will experience symptoms at unequal periods. Therefore the period of incubation must be on a sliding scale, according to the state of individual susceptibility; from twelve hours to three days it may be stated as a near approximation to the actual fact.

At the first outbreak of an epidemic, the diarrhœal stage is longer in duration for the first few cases

[1] The Practitioner, March, 1893.

[2] The Lancet, March 4, 1893.

than it is subsequently, but this difference exists for a very brief period. The usual course of the diarrhœal stage is to get well or merge into the algid state in from six hours to twelve, to twenty-four hours, even to two or three days. The more rapidly the case develops the severer its type. The average duration of the preliminary diarrhœa known to be cholera diarrhœa, is twelve hours; of the so-called cholerine is twenty-four hours; of the algid stage is three to six hours. Convalescence sets in from twelve hours to four days after the first manifestations. The typhoid stage lasts from five days to two weeks.

In every important epidemic not a few cases occur at the outset in which the patients are stricken down without any preliminary diarrhœa or other prodromes. Reiche notes this of the Hamburg epidemic. "In a majority of cases the disease set in abruptly, and at once assumed its full intensity, so that frequently, and particularly at the beginning of the epidemic, profound collapse, with diarrhœa and cramps in the calves of the legs, speedily followed the initial vomiting. Cases of fulminant cholera sicca were common at this time."[1] At Havre[2] the same violence in the action of the cholera poison was manifest, a large number passing at once into

[1] Cholera in Hamburg, *supra*.

[2] Bull. de l'Académie de Méd., October, 1892.

collapse without the preliminary diarrhœa and vomiting.

The mortality from cholera is affected by so many circumstances that no proper estimate can be made without taking them into account. To compare results in one place with those of another place without noting the influences which in one place lessened and in another increased the death-rate would be most unjust and misleading. Of the first 50 cases received into the two hospitals at Havre, 48 died. In one of these hospitals known to be badly managed, there were 36 deaths in 57 cases, but taking 604 cases of admission for cholera to the two hospitals, there were 204 deaths, or one-third (33 per cent.) died. During the epidemic in New York last fall (1892) there were 11 cases, which had no known connection with each other or with the cases at the quarantine station, or on the infected vessels, and occurred at widely separated points, and two only recovered, and doubts exist as to the genuineness of these. At the quarantine station where all the cholera coming in the vessels from Hamburg, Havre, and other infected ports, were received and treated, the results were as follows : Of 72 cases, 8 of them slight, there were 20 deaths. According to Reiche the mortality at the New General Hospital was somewhat more than 50 per cent. At the Nietleben Asylum, which is near Halle, the number of cases

up to the date of the report was 105, and of these 36 proved fatal. At Nanterre, the combined hospital and prison, of the 51 cases that occurred, 49 proved fatal. The total number of cases reported as having occurred in the Austrian Empire was 214, and of these 125 died. During the cholera epidemic in Kashmir, there were 16,845 cases, and of these, 11,712 proved fatal. In the *Lancet* report on cholera in Russia, above quoted, it is stated that the total number of cases of cholera occurring in the Russian Empire from the beginning of the epidemic to December 1st was 555,010, and of these 267,880 proved fatal. This last epidemic has proved to be more fatal than any that have preceded it. In 1831 the mortality in Russia was 42.2 per cent., whereas in 1892 it was 45.8 per cent. As respects numbers and extent of territory invaded, the epidemic of 1892 is the third in severity of the whole number of epidemics.

The general average of the mortality in the epidemics that have prevailed in this country was 50 per cent. When the local hygienic condition was especially bad the proportion of deaths was high; when fairly good the cases were much less severe, and the death-rate lower. The statistics of mortality in this country, as elsewhere, were much affected by the kind of cases included. Every case of diarrhœa was usually called cholera, and was

taken up in the returns, when the epidemic prevailed.

DIAGNOSIS AND PROGNOSIS.

Until the discovery of the comma bacillus there was no means of differentiating with certainty, or indeed at all, between cholera and cholera nostras, or morbus. Now by a proper bacteriological examination the diagnosis may be made with certainty and precision. During the present epidemic the views of Koch have been confirmed at all points. At Hamburg, at the Old and New General Hospitals, at Berlin, at the Moabit Hospital, and at Koch's Institute, the spirillum of cholera has been always discovered in the dejecta. Also, in Paris, where the extraordinary discovery of Koch was slow of recognition, the comma bacillus has been admitted to its true position as the cause of the cholera seizure, and its presence as essential to its diagnosis.

The dejecta should be examined as soon as possible after being passed, and cover-glass preparations made of the rice-water matter. The arrangements necessary for the detection of the spirillum consist of a microscope provided with oil-immersion objectives, preferably one-twelfth, one-fourth, and one-half inch, attached to a triple nose-piece, and with a stage arranged for an Abbé condenser. A drop from an

ordinary cholera stool will contain much columnar epithelium, bacilli of various kinds, and other organisms, and if the examination is made without delay colonies of the comma bacilli may be seen. If there is much time lost, and especially if the contents of the canal are not examined until some time after death, the bacillus may not be found. Prof. Drasche stated in the course of a discussion before the Medical Society of Hamburg that in some fatal cases no bacilli were found, whilst in other instances they were still present twenty-three days after recovery had taken place. Dr. Dunham, of the Carnegie Laboratory, makes a similar statement.

The direct examination of cholera matter, without preparation by cultures and staining, is never so satisfactory, whether the liquid stools themselves, or parts of clothing or bedding soiled with them, are examined. The material, whatever its nature, should be prepared in the form of plate cultures, and from these colonies transferred to other nutrient media, and the culture medium—gelatin, blood-serum, agar, or other medium—is made to solidify on glass plates, and is then inoculated with the supposed germs. Planted in this soil and maintained at a proper temperature these organisms grow, producing their own kind. If the suspected matter is adherent to articles of clothing, bedding, etc., or to silk or cotton, or other fabrics, they are put in prepared bouillon, placed in

an incubator at a suitable heat, and this bouillon culture is transferred to plate cultures, and in turn to other cultures, so as to obtain typical forms for microscopical examination. By its manner of growth, its behavior in the various nutrient media, its need for or disinclination to oxygen, the mode in which it takes the stain, and its morphological uniformity, we are to recognize the germ in question.

The original dicta of Koch regarding the determination of the nature of any given micro-organism still remain unimpeachable. That can be pronounced a true germ only if on cultivation it produces its own kind; if it is always found in the bodies of those dead with the disease; if such organism can be grown in artificial media, and the cultures thus obtained will cause the same disease in the inferior animals when inoculated therewith. The only animals thus far shown to be susceptible to the peculiar action of the cholera germ are the mouse and the guinea-pig. If a culture is introduced into the intestinal canal directly, without passing through the stomach, the same changes are brought about as those made by cholera infection in man, except that there is no such vomiting or purging, but the animal speedily dies, with the usual symptoms of gastro-intestinal disturbance, and great numbers of bacilli are found swarming on the surface of the mucous membrane, penetrating the epithelium and villi, and entering the

follicles. As the cholera germ can only fructify in alkaline media, and is destroyed by the acid gastric juice, this explains why it can be swallowed almost with entire immunity in the normal state. But when the gastric juice is neutralized by the taking of an alkali, the swallowing of the germs must give rise to characteristic phenomena such as were noted especially in the case of Prof. Emmerich. In a perfectly normal state we may suppose that the germs find conditions not altogether favorable, in fact rather hostile, in the intestinal canal. It seems probable, indeed, that there must be some preparation made for the reception and growth of the germ, and that the absence of such arrangements neutralizes the efforts of the parasite to establish itself. From favorable to restraining conditions there are many gradations, and hence the occurrence of mild or severe cases, of the simplest diarrhœa or of the fulminant form causing death in a few hours.

The prognosis of cholera is necessarily grave. The number of bacilli present is not conclusive, for as we have already seen, the patient may be *in extremis* and yet few bacilli be found. The prognosis may be favorable when the diarrhœa is the only symptom, but when nausea and vomiting occur and the discharges are of the rice-water kind, and especially when cramps come on, and circulation fails, only the most gloomy prognostication is reasonable. From the

algid stage few emerge alive. It is necessary to be on one's guard when the vomiting and purging cease —the patient's condition is not otherwise improved, for this may signify the onset of coma. If the urine is secreted again, and especially if this is coincident with a reappearance of bile in the evacuations, the outlook is hopeful; but an insufficient secretion is significant of a protracted convalescence, and, it may be, a fatal result at last.

CHAPTER V.

THE TREATMENT OF CHOLERA.

PREVENTION.—*Vaccination; Quarantine; Personal and Municipal Hygiene, etc.*

TREATMENT.—*Medicinal; Enteroclysis; Venous Transfusion; Hypodermatoclysis, etc.*

UNTIL the discovery of the spirillum of cholera, there had been no basis of a scientific character for the treatment of this disease. The empirical methods made use of in former epidemics proved singularly unfruitful in curative results. During the present epidemic, new remedies, applied in accordance with a more exact and truer conception of the therapeutical diagnosis, have been employed. It is only less important to note the failures than to apply new remedies with a more just conception of their powers.

If therapy has accomplished little, sanitation has done much. If the mortality rate continues at nearly the same level, it is certain that the epidemic influence has declined considerably in force, and that the number and severity of the cases in communities and individuals are constantly lessening as compared with former experiences. Since to prevent a disease occur-

ring is much better than to cure it after it has appeared, in the management of a cholera epidemic it were far more desirable in every aspect to stop its progress than to experiment with remedies against individual cases. During the present epidemic there have been two striking object lessons showing the value of local and domestic sanitation, and of quarantine. The first is the instance of London, where the authorities relied on cleanliness and disinfection; the second is the case of New York, where an efficient quarantine was maintained, and but eleven cases —two of these doubtful—occurred in the city, and at points distant from each other and not communicating by persons or things. As the harbor of New York was in constant communication with Hamburg, Bremen, Havre, Paris, and other infected places, the success of the quarantine arrangements can hardly be doubted. London, whilst much nearer to the sources of infection than New York and unprotected by quarantine, escaped nearly as well, and no epidemic of cholera made its appearance there.

The management of cholera includes *prevention* as well as *therapy*. I purpose to consider first those agencies employed to keep out cholera, or to destroy its germs should they obtain a foothold—all the measures of an enlightened private and public hygiene.

Public sanitation; quarantine; sanitary cordons,

and the hygiene of the individual, are all concerned in this aspect of the treatment required in cholera epidemics. Since it has been established that cholera follows the routes of commerce and travels no faster than men proceed by the ordinary channels of communication, it has become evident that restriction in the commerce of infected peoples is necessary when an epidemic of cholera is on the march. At those points whence the epidemic influence starts, precautionary measures should be instituted. Certain places in India and Arabia being natural homes of the cholera germ, should be so thoroughly treated as to exterminate the poison at its source, or these places should be so surrounded by sanitary cordons that the infection would be restrained within them, and here the final efforts to destroy the pathogenic microorganisms should be made. The disease should be stamped out at its home.

Quarantine.—No doubt should now be entertained of the efficiency of a proper quarantine in arresting the spread of cholera. It is not only the individual but his belongings that must be stopped; not only the persons and personal effects from an infected district, but goods of various kinds, especially rags coming from cities the seat of epidemic influence. Paper money must be included amongst such belongings. To stop communication from an infected area, absolutely, is the most certain kind of quarantine

that can be instituted. As the necessities of commerce will not permit such a measure as complete isolation, less efficient and partial quarantine must be substituted. Detention till the period of incubation be passed, disinfection of clothing and effects, and the most rigorous application of all the rules of personal hygiene are the measures of quarantine to be made use of As for the most part quarantine is established on the sea-coast, at the ports of entry, inspection of vessels is an important duty. With any evidences of cholera existing on board of an emigrant or passenger ship, the crew and passengers should be disembarked, the sick separated from the healthy, and all parts of the ship, the hold, storerooms, steerage quarters, cabins, staterooms, etc., should be thoroughly disinfected with superheated steam, or, what late experiments have shown to be better, hot dry air, and the articles and clothing about the person of the sick should be burned. Clothing and goods can be treated most effectively by exposure to a hot dry air, which Dr. Sternberg[1] has shown to be more useful and less hurtful to fabrics and silks than steam. The direct sunlight is destructive of germs, and hence clothing and bedding hung up in the sunshine alone, are presently freed from the cholera spirillum. In the course of an experimental research

[1] The Practitioner, London, March, 1893, p. 227.

to ascertain the effect of desiccation, Sternberg found it to be effective, and that "free exposure to fresh air and sunshine is one of the most reliable methods of disinfecting articles which have attached to them this cholera spirillum." The "thermal death-point" of the cholera germ in a moist state is about 130° F. and not more than ten minutes' exposure is required. If the moisture from the application of steam heat remains in the goods, any germs that escaped destruction will be kept in a viable state. This is a serious objection to the use of superheated steam. It were better to subject all articles in contact with cholera patients to the action of dry air at a temperature of 80° to 100° C., in a suitable chamber or drying oven. The articles must be carefully separated so that the hot air can come into actual contact with every piece.

It was the conclusion of the International Sanitary Conference at Rome, that "disinfection of merchandise and of the mails is unnecessary." Koch maintains the same ground, and Sternberg is also of this opinion. Now Uffelmann[1] finds that the spirillum remains active and capable of reproduction, on the printed page, seventeen hours, and on writing-paper enclosed in an envelope, twenty-four hours. Woollen and cotton goods, contained in the original packages,

[1] Berliner klinische Wochenschrift, No. 48, 1892.

are not dangerous if they have simply passed through an infected port, and they do not require disinfection. Such articles of merchandise as hides, especially in the green state; fish, furs, and especially rags, require careful disinfection, if they have been exposed to infection at any point in transit. Sternberg considers "the washing of the exterior of packages of merchandise with a solution of mercuric chloride, and the fumigation of the mails with sulphur dioxide," an "unnecessary procedure, unless the merchandise has been exposed to infection by the dejecta of cholera patients during the voyage or after its arrival at our ports."

As regards the individual, all exposed to infection, as when cholera has appeared on shipboard, should be bathed, their personal effects and clothing disinfected, and they should be carefully separated from the sick and the convalescent. The bedding and clothing intended to be burned, should be well treated with a solution of corrosive sublimate 1 : 500, or of zinc chloride 1 : 100 before being put in the furnace. Passengers arriving at New York quarantine and Americans passing the sanitary cordons on the Continent of Europe, complained loudly of the injury done to their effects by the disinfection. Silks, laces, and fine fabrics generally, were so damaged as to be unfit for use again. Some of the injury done is mechanical, but the superheated steam, the solutions

of sublimate and of zinc chloride, the gases, sulphurous acid, chlorine, etc., are very destructive of fine clothing, laces, silks, etc., as well as of germs. Sulphurous acid forms colorless soluble sulphites, which leave the fabric decolorized and its texture injured. Chlorine gas is very hurtful to the respiratory organs and is apt to cause croupous pneumonia, but it is a powerful oxidizing germicide. Either sulphurous acid gas or chlorine gas is sufficiently powerful to destroy the spirillum of cholera, and the method of procedure is simple and the cost trifling. In the one case to burn sulphur on a pan of coals, in the other to act on chlorinated lime with hydrochloric acid, suffice to develop the gases in a few minutes. An exposure of a few hours of the infected clothing hung up in a tightly closed apartment will destroy all infectious matter.

Quarantine on land, at the border of States, is carried on by means of a sanitary cordon with a central station, and outlying pickets and inspectors placed on the roadways and at railway stations to overhaul all persons and things going from an infected district into one free from the epidemic influence. At the central station are placed the appliances for inspection and disinfection of persons and things. On the Continent of Europe, when cholera is prevailing in some special locality, the sanitary cordon is established at those places where the railway lines cross

the frontiers. In some few instances in this country where the yellow fever has threatened a given locality, such sanitary cordons have been established, but with little success.

The German Government has issued instructions about disinfection, of which the following is an abstract. The disinfectants are "milk of lime," one part of lime to four of water; chloride of lime; 3 per cent. solution of potash soap; solution of carbolic acid—the liquefied acid made so by the addition of 5 per cent. of water; steam under pressure of not less than a tenth of an atmosphere; boiling water. The articles to be disinfected to be boiled at least a half-hour.

The liquid discharges to be received as far as possible in vessels mixed with an equal volume of milk of lime and allowed to remain in contact at least one hour. Chloride of lime may be used, two heaping tablespoonfuls of the powder to each half-litre (one pint). Only fifteen minutes are required.

The hands and other parts of the body coming in contact with infected articles, with the discharges, soiled clothes, etc., must be disinfected each time by thorough washing with solution of chloride of lime, or of carbolic acid.

Bed and body linen and other articles of clothing which may be washed, should be put in receptacles with disinfectants immediately on being soiled.

Either the solution of soap or of carbolic acid may be used. In the former they should remain at least twenty-four hours, in the latter, at least twelve hours before being rinsed and further cleaned.

Clothing that cannot be washed may be disinfected by steam. Leather articles may be wiped with carbolic acid or chloride of lime solution.

Wooden and metallic parts of furniture and similar articles should be carefully and repeatedly rubbed with cloths with carbolic or potash soap solution. The floors of sick-rooms should be treated in the same way. The rags used should be burned. Floors can also be disinfected by milk of lime, which may be washed off after two hours of contact.

Walls and woodwork may be whitewashed. After disinfection the rooms should be left unoccupied and well aired.

The ground, pavement, and gutters fouled by cholera discharges, or in which suspicious waste runs, can be disinfected by copious flooding with milk of lime.

In privies a litre (one quart) of milk of lime should be poured daily down each seat opening. The seats should be washed with the potash soap solution.

At the Quarantine Station, New York, the following method of disinfection was carried out:

The immigrants were first well rubbed with a bountiful supply of green soap, and then bathed.

The bath-tub consisted of a sail suspended at the four corners, the water constantly running. The crew's quarters and the steerage were scrubbed and washed out with a solution of corrosive sublimate 1 : 500. The baggage and clothing were disinfected by sulphurous acid gas (burning sulphur), superheated steam, and, where injury would not be done, by corrosive sublimate solution. Soiled clothing and bedding were wrapped in sheets wetted in corrosive sublimate solution and burned in the furnaces.[1]

During an epidemic of cholera, the condition of every individual becomes a matter of grave importance. Just as filth, improper food, and dissipated habits invite the germs, so an opposite state prevents their lodgment. Especially is it necessary for those about the sick, nurses, attendants, and physicians, to avoid becoming conveyers of the poison, by the utmost cleanliness of the person, by putting aside all clothing worn whilst with the sick, and by avoiding contact with the cholera matter at any point. The physician, on leaving a cholera patient, should carefully wash his hands with soap and water and use his nail-brush thoroughly, and also immerse his hands in a corrosive sublimate solution 1 : 500. Nurses and attendants on the sick should, besides washing the hands as above suggested, have a bath

[1] The Cholera of 1892 in New York. By Reynold W. Wilcox, M.D., LL.D.

and fumigate their clothing and effects in sulphurous acid or chlorine gases.

As the chief source of contamination—the chief carrier of contagion—is drinking-water, only water that has been boiled should be allowed. When there is hot water laid on, it suffices to use the water of the hot-water tap—for in that case the water is boiled in passing through the water-back of the range—and boiled, too, under the pressure of steam. It is far safer to make use of artificial ice during the existence of a cholera epidemic, for the natural ice is too often cut from superficial ponds of surface water, and the cholera germs, although inhibited at the freezing temperature, recover their vitality at the thawing. The river water is often rejected for the water of springs, when cholera is prevalent, but unwisely so, for the springs are readily enough contaminated through the ground-water. Fermented drinks—beer, ale, etc.—wine and spirits should be avoided, especially by those who are unaccustomed to their use. Brandy is consumed by the timid to keep up the vital powers, and some special kind of liquor is apt to be decided on as peculiarly fitted for the emergency, and drunk in amazing quantity. Such conduct only invites seizures. Indigestible food, badly cooked vegetables, unripe fruits, are partaken of by the ignorant and the careless, and many persons who always indulged in a full diet, eating everything, now restrict themselves

to a few articles, meat chiefly, avoiding vegetables and fruit. Changes of this kind are as injurious almost as excessive indulgence. Extremes in diet, and bad quality of food, are hurtful by setting up a catarrhal process in the small intestine, and this in turn favors the reception of the spirillum of cholera by inducing alkaline fermentation and thus increasing the alkalinity of the intestinal contents.

Should a case of cholera occur in any given locality, measures should be at once instituted to "stamp out" the infection. If feasible, the dead should be cremated, and all articles of clothing and bedding employed about the sick should be burned, or treated with disinfectants and by desiccation according to the methods already set forth. The rooms, the walls, the floors should be washed down with the disinfectant solutions; the gases, sulphurous acid and chlorine, should be disengaged in the rooms the sick occupied, and before being inhabited again they should be opened as freely as possible to the external air for several days. The methods of disinfection and of "stamping out" advised by the Prussian Government can be made use of, if desired, and they are at the same time cheap and efficient. Also, the method employed at quarantine, New York harbor, may be applied to the local circumstances of an outbreak at any interior point when cases and deaths announce its beginning.

Cholera Vaccine.—A method of prevention, entirely new as respects its application to cholera, is Haffkine's vaccination,[1] but the way had been prepared for it, not only as respects the vaccinia of smallpox, but in the virus attenuations of Koch for producing *tuberculin*, and in Pasteur's attenuation of hydrophobia virus.

According to Haffkine, microbial infections are of two kinds: Septicæmias and Intoxications. The septicæmia is caused by the development of the microbe in the blood; the intoxication is due to the absorption of a product of the life-growth of the microbe from its point of activity in the body. Cholera is one of the intoxications—that is, it is due to the absorption of a ptomaine produced by the bacillus, and absorbed from the intestinal canal. The comma bacillus cannot exist in the blood, or in the tissues of the body at any point, except on the surface of the intestinal mucous membrane, or deeper when ulcerations exist to afford the necessary outlet. In Haffkine's system there are two strengths of the cholera virus: an attenuated virus, and an exalted virus. The exalted virus is obtained by inoculating the peritoneum in a succession of rabbits each with the fluid drawn from the preceding rabbit. The

[1] The British Medical Journal, February 4, 1893, "Haffkine's Method of Vaccination Against Asiatic Cholera," by E. A. Wright, M.D., and Surgeon-Captain D. Bruce, M.D.

"vaccines" are two: 1. An emulsion of colonies of bacilli cultivated on agar—living vaccine; 2. Carbolized, which is the same as No. 1, except made in a 5 per cent. solution of carbolic acid, and containing no living bacteria. The vaccines are injected hypodermatically. It may well be questioned here how far the bacilli and how far the peritoneal fluid are active in the production of the resulting phenomena. It was known twenty years ago that the peritoneum developed a highly toxic liquid when excited to inflammation by the invasion of foreign matters, infectious or not, and that the poisonous character of the fluid obtained was greatly intensified by successive inoculations of the cavity with the resulting liquid from each preceding.

As a prophylactic measure it has been proposed recently to inject subcutaneously the serum of the blood of cholera subjects. It is well known that normal blood serum is antagonistic to pathogenic organisms. The use of the serum from the blood of cholera subjects is a measure of prevention, as it renders the individual thus inoculated immune to the cholera poison. Such is the theory, and in Russia many hundreds have already been subjected to the treatment, with alleged success. So many persons escape from an attack, even when an epidemic is most active, that such a mode of protection must remain in doubt. On the other hand, if an inoculated sub-

ject be attacked, the method is at once discredited. If it prove effective, the result must be due, not to the spirillum itself, but to a toxine produced by it—for, as now known, this organism is found only in the intestinal canal and never in the blood.

The Medicinal Treatment of Cholera.—As the first distinct evidence of the presence of cholera is the occurrence of diarrhœa, so this symptom is of the first importance from the point of view of the treatment. The morbid complex demanding the application of remedies is the following: a watery diarrhœa; an excessive alkalinity of the intestinal juices; beginning detachment of the epithelium, and the growth of a micro-organism on the surface of the mucosa. As we have to deal with a foreign body in a process of change, producing a colloidal substance of active toxic power, the question of elimination rises into importance. It seems to be an eminently rational procedure to attempt to rid the intestinal canal of the spirillum, the growth and development of which gives rise to the disturbance. It is sought to accomplish this by the use of eliminants. Although not the first to have suggested this practice, Dr. George Johnson, of London, has been its most persistent and able advocate for a quarter of a century—during the epidemic of 1866 and since. Condemning opium and astringents, his notion was to secure complete elimination from the intestinal

canal by the exhibition of an ounce or two of castor oil before endeavoring to stop the diarrhœa. Since the discovery of the comma bacillus, this method wears a rational aspect and has been carried out elsewhere in a modified form. In Russia, according to the method of Vachovitch,[1] calomel is given and followed by castor oil emulsion, with which is combined naphthalin. In such a combination, with the eliminant action of the castor oil is associated the germicide powers of calomel and naphthalin. The cholera subject under ordinary circumstances is unable to retain castor oil, and, hence, any utility it may have is confined to the first onset of the diarrhœa, when less unpleasant remedies will prove effective.

Unquestionably the first remedy for the treatment of cholera diarrhœa is a mineral acid, or, as the French school prefer, lactic acid. I have seen more good accomplished by the exhibition of aromatic sulphuric acid with some opium than by any other remedies.

℞.—Acid. sulphuric. aromat. . . 4. = ʒj.
Tinct. opii deodorat. . . 2. = ʒss.—M.

S.—From ten to twenty drops every half-hour, hour, or longer as required, in some cold water.

Dilute sulphuric acid may be substituted for the

[1] Bull. gén. de Thérap., February 15, 1893, p. 143.

aromatic, and for the deodorized tincture, the camphorated tincture of opium.

℞.—Acid. sulphuric. dil. . . . . 16.
Tinct. opii camph. . . . . 32.—M.

S.—A teaspoonful in some cold water every half-hour as required, or more or less frequently.

Some advantages, as containing benzoic acid and oil of aniseed, are possessed by paregoric over the deodorized tincture, and it may be substituted. In Paris, lactic acid was much used. The following is the formula of Dujardin-Beaumetz:[1]

℞.—Lactic acid . . . . . 10.
Syrup . . . . . 20.
Tincture of citron . . . . . 2.
Water . . . . . 1000.—M.

S.—Three spoonfuls every quarter of an hour.
With this was often given twenty drops of paregoric.

In former epidemics Hope's mixture, consisting of nitric acid with some nitrous, tincture of opium, and camphor water, was much relied on for the preliminary diarrhœa. At New York quarantine all suspected cases were made to drink "hydrochloric acid lemonade" 1 : 1000, and in some cases the same solution was used to irrigate the stomach. This practice was advocated by Professor Hayem especially. MM. Mendel and Simon[2] recommend

[1] Bull gén. de Thérap., December 30, 1892. [2] Ibid.

for the cholera diarrhœa hydrochloric acid with cocaine and some tincture of opium, as follows:

℞.—Acid. hydrochloric. . . . 2.
Cocaine hydrochlorat. . . . 0.12.
Tincture of opium . . . 2.
Distilled water . . . . 170.
Syrup . . . . . 200. —M.

S.—A teaspoonful every two hours.

The vegetable acids, tannic and gallic, were also given in pill form, variously combined, in former epidemics. Tannin, opium, and acetate of lead, with or without capsicum, were much employed. For example:

℞.—Acid. tannici } . . . āā gr. xij.
Plumbi acetat. }
Opii . . . . . gr. ij.
Oleoresinæ capsici . . . gr. iij.—M.

Ft. pil. no. xij.

S.—One pill every hour, or every two, three, or four hours.

Tannic acid was also often given in combination with camphor and opium for the preliminary diarrhœa—thus:

℞.—Acid. tannic. . . . . ℈j.
Camphoræ . . . . . gr. x.
Opii . . . . . gr. ij.—M.

Ft. pil. no. xx.

S.—One pill every hour or two.

Before quitting the subject of the acids in the treatment of cholera, I should not fail to mention the suggestion, said to have come from America, of injecting sulphuric acid subcutaneously:

R.—Acid. sulphuric. dil.	1.35 Gm.	=	♏xx.
Morphinæ . .	0.01 Gm.	=	$\frac{1}{6}$ gr.
Distilled water .	14. Gm.	=	f ʒss.—M.

S.—For one injection.

Lauenstein, of Hamburg, tried this, but was forced to give it up because it caused *colossal gangrene*. That such an injection would cause abscesses and sloughing can hardly be doubted by anyone familiar with the effects of acid solutions thrown under the skin.

A great many astringent combinations were formerly prescribed—astringent and anodyne. Camphor entered largely into these, and in the form of Rubini's solution—a saturated solution in pure alcohol—it was greatly used alone, especially by homœopathic practitioners. It is difficult of administration, because the alcohol quickly evaporates, leaving the solid camphor on the tongue. I have known of an instance in which it was said the death of a homœopathic doctor was caused by a heavy deposit of camphor in the throat, to whom Rubini's solution was given rapidly, in the algid stage. Camphor, bismuth, acetate of lead, and opium were frequently prescribed

together for the diarrhœa in the last epidemics before the present. The oleoresin of tannin entered into such combinations to obviate the coldness and depression of the approaching algid stage. For example:

℞.—Bismuthi subnitrat. . . . ʒij.
Plumbi acetat. . . . . gr. xij.
Camphoræ . . . . . gr. vj.
Oleoresinæ capsici . . . . gr. iij.—M.
Ft. pulv. no. xij.
S.—One every hour or two.

In India, chlorodyne has had the first place as a remedy for cholera since it was originally proposed by Dr. J. Collis Browne, of the Indian Army, notwithstanding it is a proprietary remedy and the exact composition unknown. Many imitations of it have appeared from time to time, some of them very close, but not one of them having precisely the same ingredients. The original chlorodyne contains morphine, atropine, cannabis indica extract, hydrocyanic acid, glycerin, and treacle. Such a combination is effective in the diarrhœal stage, but is relied on in every phase of the cholera seizure by the people of India, and the statistical results seem to be in its favor. When, however, stupor and the algid stage approach, opium or its alkaloid morphine becomes objectionable—less so, however, if the combination contains an agent which, like atropine and cannabis

indica, antagonizes the soporific and depressing effects of opium or morphine. With this, as in the use of opium in any form, it is necessary to avoid narcotism. The dose of chlorodyne ranges from five minims to twenty, repeated according to the state of the case.

Almost any of the remedies above referred to may succeed in the arrest of the cholera diarrhœa if given timely, but when systemic infection occurs the remedies must possess different powers. Since the discovery of the comma bacillus in 1883 by Koch, various antiseptics have been resorted to in the expectation that the germs being destroyed the local and systemic conditions would subside. Amongst these are salol, creolin, naphthalin, naphthol, carbolic acid, creasote, salicylate of bismuth, arsenic, etc. The most confident expectations were entertained of the curative powers of salol. Composed as it is of salicylic acid and phenol, and decomposed into its constituents by an alkali, it was supposed that this reaction would occur in the small intestine and there the germs be destroyed. The first trials were reported on favorably, but presently it was found that these new remedies brought us no nearer to the cure than those long in use. Salol and creolin were tried freely in Hamburg (Reiche), in Berlin (Guttmann), and elsewhere, but were found useless. Naphthalin was used in some localities with marked

advantage, notably in Russia. Thus, E. Vachovitch[1] gave it in wafers every half-hour, but he also administered calomel at the same time, and to this must be ascribed some of the undeniable benefit obtained. I myself have seen so much curative effect from the use of naphthalin in diarrhœa that I cannot doubt it must be efficacious in cholera diarrhœa. As under its use the stools lose their characteristic odor—become odorless, in fact—it can hardly be doubtful that it acts on the micro-organisms infesting the canal. Naphthalin may be given with bismuth, creasote, or other disinfectants. Beta-naphthol is preferred by some, and, from the theoretical standpoint, it promises well. Iodoform[2] has been employed by Dr. Bujwid as a prophylactic when the cholera diarrhœa first manifests itself. In some experimental work Dr. Bujwid found iodoform to be exceedingly destructive to the comma bacillus, so small a proportion as 1 : 1000 proving fatal in a minute. Iodoform may be given in a powder, or wafer, or packet with naphthalin and other antiseptics, as follows:

℞.—Iodoformi . . . . . ℈j.
Naphthalin. . . . . ℈ij.
Bismuthi salicylat. . . . . ʒij.—M.
Ft. pulv. no. xx.
S.—One every hour or two.

[1] Vratch, No. 37, 1892. Quoted by the Bull. gén. de Thérap., February 15, 1893.

[2] Deutsche med. Zeitung, quoted in Centralblatt für die gesammte Therapie.

Probably the best vehicle for such a powder is milk. It should be stirred up quickly and tossed off.

An excellent remedy for the antiseptic treatment of cholera is arsenic. I am not sure that the arseniate of soda is not preferable to the arsenite of potassium. It is usual to combine some tincture of opium with the liquor sodii arseniatis or liquor potasii arsenitis, so the patient receives five to ten drops of the tincture of opium with one to two drops of the solution.

Since the epidemic march of cholera began up to the present moment, calomel has occupied a large space in the therapeutics of cholera—formerly as a remedy given to re-establish the biliary functions; lately, as an intestinal disinfectant. Formerly it was held that calomel restores the secretions suspended by the cholera poison; now it is supposed to exercise a germicidal power—to arrest the action of the bacillus and prevent the formation of the cholera toxine. In former epidemics calomel was given in ℈j to ʒj doses to stop vomiting, and in smaller doses at shorter intervals when the object was to "change the secretions." There can be no doubt that calomel was more prized during former epidemics of cholera than any other remedy. The present epidemic has not lessened—has rather increased, indeed, the repute in which it has been held. There is a marked unanimity in the reports from

Hamburg, Havre, Paris, Berlin, and other places where cholera has been prevailing. The mode of administration has been singularly alike in the various centres of infection: a single large dose at the outset—about eight grains—and smaller doses of one or two grains every half-hour, every hour, or two hours, until colored discharges occurred or fatal symptoms came on. Calomel was also added to the astringent and antiseptic combinations already given—in Russia, given with naphthalin; in Paris, with bismuth, etc.

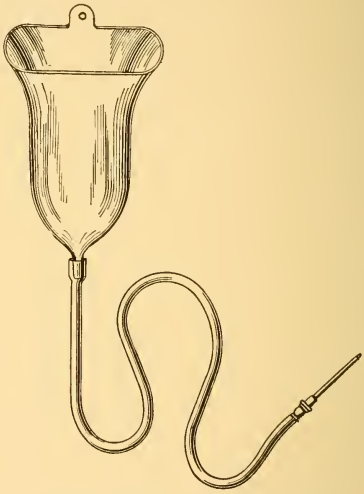
The method of treatment entitled *enteroclysis*, introduced by Cantani, is a novel expedient which has proved useful to some extent. It has been employed in all stages of the cholera seizure, and is extremely praised by Ziemssen for its constant utility at every period. There is, however, some difference of opinion respecting its real value as a remedy. The formula as proposed by Cantani is as follows:

℞.—Infusion of chamomile . . . 2 litres = 2 quarts.
Tannic acid . . 5 to 20 Gm. = ʒjss-ℨj.
Laudanum . . 20 to 30 drops.
Gum arabic . . 30 to 50 Gm. = 1 oz. to 1¾ oz.

The process consists merely in irrigation of the bowels with a solution of tannic acid, and the simplest apparatus suffices—a fountain or Davidson's

syringe serving perfectly well for this purpose (Fig. 7). To insure passage of the fluid beyond the sigmoid flexure a flexible rectal tube should be introduced and connected with the distal extremity of the

Fig. 7.



A glass fountain syringe with the needle attached.

syringe tube. The patient should lie on his back or right side with the knees well drawn up, and the abdomen should be gently kneaded to pass the fluid through the ileo-cæcal valve. Differences of opinion exist as to the flow of fluid backward through the

valve. Certainly in the normal state it is difficult to effect this, if it be not impossible. The most recent experiments[1] undertaken to prove the permeability of the orifice have established it only in part. It was found in a series of seven trials to ascertain whether the fluid passed through the ileo-cæcal valve, that in nearly one-half of the subjects the orifice remained closed and the fluid could not be forced through. These trials were made on cholera subjects. In the treatment of some cases by enteroclysis it was found that the tannin solution was in part rejected by vomiting. The evidence, therefore, is conclusive that the solution in many cases certainly can be made to pass through the ileo-cæcal valve, notwithstanding the experimental trials which heretofore have seemed to prove the contrary. The utility of the tannin consists in the chemical action it is supposed to exert on the mucous membrane and on the comma bacillus, in checking the transudation from the vessels and in restraining the diarrhœa. It is a remedy to be employed especially during the diarrhœal stage, but, according to Ziemssen, it is useful at all stages of the disease. Rumpf, of Hamburg, has found it useless,

[1] Dr. Judson Daland, at Swinburne Island, New York Quarantine. He experimented on the bodies of children only: one, six years old; the others, two years old. In two, the valve was competent to prevent irrigation of the small intestine; in one, a twist of the intestine prevented success, and in four the valve was passed without difficulty. Trans. Coll. of Phys. of Philadelphia, 1892, p. 210.

except before the stage of infection—the algid stage—and that seems to be the impression of many in regard to its real place in the treatment.

Besides tannin, or in conjunction with it, various antiseptic solutions can be used by enteroclysis. A weak solution of corrosive chloride, 1 : 5000, or of carbolate of zinc 1 : 1000, or of silver nitrate 1 : 1000, may be employed in this way. The mere douching of the bowel with hot water—as hot as can be borne—has had a good effect, increasing the warmth of the body, raising the heart-beat, and washing out the retained "rice-water" matters. Enemata of starch and laudanum were a good deal used in former epidemics. They have been employed sparingly in the present epidemic to restrain diarrhœa.

As respects the use of opium in cholera, the experience of the present epidemic is remarkably uniform—that it is hurtful if employed freely even during the diarrhœal stage, but still more so if the narcotic effect is superadded to the stupor or coma of the algid stage. Reiche, Rumpf of Hamburg, Guttmann of Berlin, and Ziemssen oppose the use of opium in large doses, especially at the approach of, or during the algid stage, but favor its use for the relief of cramp, and to check the early diarrhœa. It is highly probable that the numerous remedies for the diarrhœa would avail little were this constituent

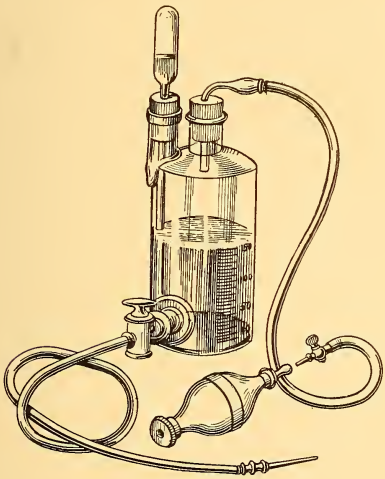
omitted from the formulæ. In fact, it is necessary to an effective treatment of the cholera diarrhœa, but when the kidneys have ceased to functionate, and uræmic symptoms are manifest, and when the loss of serum has so damaged the red blood-globules that they cease to carry oxygen, the effects of opium only intensify these conditions.

Almost any remedy or any of the combinations of remedies above mentioned will usually arrest the preliminary diarrhœa if given early enough, and before systemic infection occurs, and if the patient's condition is favorable. Nevertheless, in some cases, from the earliest beginning of symptoms no remedy seems equal to the arrest of the disease, and purging and vomiting go on despite the most diligent application of the most approved means; in some, the algid stage is ushered in tempestuously after one or two discharges; in others the patient is stricken down suddenly, profoundly intoxicated, but without diarrhœa or vomiting, and the algid stage is at once fully developed. Ordinary remedies seem powerless under these circumstances. Whatever offers to be done must be carried out without delay. As the problem requiring immediate solution is the restoration of the fluidity of the blood, whereby the organs now in a state of suspended activity can be made to functionate, the first step is to supply the vascular system with the needful material. The loss is that of the

blood serum; the supply must be of a material to take its place. So long ago as 1834 the disastrous effects of the diffusion from the bloodvessels were fully understood, and the means of relief suggested. Injection of fluid into the veins was naturally supposed to be the appropriate remedy, and the attempt was then made to arouse patients from the algid state by an intra-venous infusion of salines. This practice has been followed to some extent in every epidemic since, but until the present, ill success has attended it; the first marvellous resuscitation of the patient was not sustained, but he quickly lapsed again into the algid state and then expired. Improvements have been made in the technique, so that now the little operation of infusion of salines can be performed more easily and safely than formerly, and with a constantly improving ratio of recoveries. The apparatus required consists of a glass reservoir, a flexible tube, and a suitable needle canula for perforating the vein (Fig. 8). The transfusion apparatus of Roussel, or any of the simpler kinds employed for blood transfusion may be utilized for this purpose; but, on the whole, the simple fountain with its flexible tube and perforated needle suffices. The whole apparatus must be sterilized by boiling in water, and the water used in making the solution must also be sterilized. The composition of the solution employed varies a little, but no radical differences exist.

As a rule, it is merely a common salt solution, varied with sulphate or carbonate of soda, or the phosphate of sodium with the sulphate and chloride of sodium.

FIG. 8.



Apparatus for intra-venous infusion.

The usual proportions are as follows:

℞.—Water, sterilized	. 1000.	= 1	quart.
Sodium bicarbonate	. 1.	= 15.5	grains.
Sodium chloride	. 6.	= 95	"

Considerable variations as respects the amount infused at one time, as well as the ingredients, are to

be noted. Some prefer the sulphate of sodium to the bicarbonate, and others the phosphate of sodium; some add alcohol or brandy, others hydrogen dioxide. Again, there is a general conviction that the salt solution, alone, suffices. The temperature of the fluid should be from 100° F. to 104° F., usually at the latter figure. The quantity of fluid thrown into the veins in cases at Hamburg, Paris, and Berlin, has been quite extraordinary—from one to two litres is advised, and as much as four litres—four quarts—have been given. The intra-venous injections have been repeated in a half-hour, in an hour, or two to four hours, according to the effect of the preceding infusions. It is necessary to avoid the entrance of air, though experience and experiment have shown that the dangers of this accident have been much exaggerated. Foreign bodies, especially micro-organisms, should be vigorously excluded. The apparatus should be carefully sterilized in advance. A vein at the elbow, or the saphena vein, may be selected. Schede,[1] in a discussion before the Hamburg Medical Society, strongly advocated the method of arterial transfusion of Landois, a small artery—the posterior tibial, for example—being selected for this purpose.

Although the large amounts of fluid passed into

[1] Centralblatt für die gesammte Therapie, December, 1893.

the veins were apparently beneficial, I am yet skeptical as to the real value of such heroic measures. It has been found that in the transfusion of blood to relieve the effects of hemorrhage, only a few ounces —not more than four—can be advantageously made use of, and that large quantities overwhelm the heart or seriously embarrass its movements. I fear that the sudden infusion of so much fluid in the vascular system only precipitates a return of the outward diffusion from the veins. So remarkable are the results of the saline infusion by litre in quantity, that only two operators seem to have tried the less brilliant procedure of using a comparatively small dose. The immediate effects of the transfusion are striking: the cold, shrunken, voiceless and pulseless patient seems to pass from death to active life; his warmth is restored, and the pulse reappears at the wrist; his face and his sunken, glazed eye fill out again, and his strength so marvellously returns that he may be able to sit up and converse with those about him, or even walk about the room. In but a small proportion of cases, we shall find, are the results permanent. In a few minutes to three or four hours, the vomiting and purging come on again, and in a short time the algid state is resumed. A repetition of the saline infusion is followed by similar good effects, but they last a shorter time, and the collapse that follows increases in depth with each repetition of the operation. In a

small proportion of cases the improvement due to the saline infusion is maintained and the patient passes into prompt convalescence.

Accidents from the intra-venous transfusion are uncommon. No abscesses, no thrombosis or embolism, no septicæmia, followed the operation at Hamburg. At the moment of the passage of the fluid into the veins some giddiness, singing in the ears, and a sense of pressure within the cranium are experienced. An uncomfortable sense of tingling and burning is felt in the skin, and not unfrequently a general outbreak of urticaria, or the larger and more voluminous wheals of erythema nodosum, appear on the surface.

As regards the curative results, it must be admitted that they are not very striking, but at the same time the transfusion of salines is a distinct advance on former methods, and more may be expected of this treatment as experience grows. Lanenstein, of Hamburg, gives his results as follows: Of 173 cases, all of them grave, 54 were cured by infusions, and of this 54, 28 were treated by the intra-venous method. Of the city of Hamburg in general, Reiche reports the recoveries after intra-venous transfusion as about 25 per cent. It must be understood, however, that only in cases in the algid state was this procedure resorted to. Although there are no exact data as to the proportion of recoveries from this stage of

the disease, it can hardly be doubted that the relative number is far greater by saline transfusion than in cases treated on other lines.

The method of treatment by *hypodermatoclysis* is entirely modern—a creation of the existing epidemic, and, like enteroclysis, was the suggestion of Cantani. It is "hypodermatic infusion," and as such has long been known and practised; but as now utilized as hypodermatoclysis, it is so far a departure from the original procedure as to constitute a new method of therapy. It consists in the injection beneath the skin of a saline solution, instead of injecting it or transfusing into the veins. The solution of Cantani is the following:

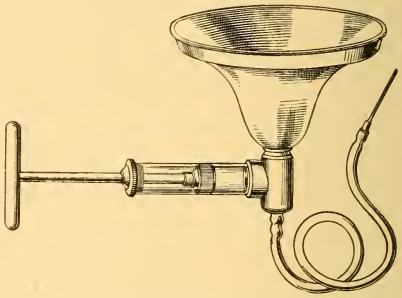
℞.—Water, sterilized .	1000 Gm.	= 1 l.	= 1 qt.
Salt . . .	10 "		= 3ijss.
Carbonate of sodium	5 "		= 77 grs.

Nothnagel made use of this formula: Sterilized water = 1 quart, in which are dissolved 6 grammes (93 grains) of carbonate of sodium and 8 grammes (120 grains) of common salt. Samuel, the author of the continuous method, favors a simple solution of common salt in sterilized water—4 grammes (3j) to 1 litre = quart, at 104° F. To the saline solution Rumpf added hydrogen dioxide, Heyse, alcohol, and others have made use of thymol, boric acid, and other antiseptics. There is no particular utility in

these additions, and one solution may be employed instead of another.

The apparatus required is of the simplest character: merely a reservoir, a flexible tube and the hypodermatic needle attached thereto. A fountain or a Davidson syringe serves the purpose perfectly well. The several parts of the apparatus must be

Fig. 9.



A form of reservoir with pump to insure the passage of the fluid, used in Germany.

carefully sterilized before using. The purpose to be accomplished is to introduce under the skin as large a quantity of the fluid as can be made to enter at each operation, every half-hour to every four hours. As the attempt is made to pass into the blood from one to four litres (one to four quarts), time is required to accomplish this, and hence the plan proposed by

Samuel and known by his name—"Samuel's continuous method." By this method the needle remains *in situ*, and the fountain is so elevated as to permit the flow *guttatim*, so that the skin be not so distended at once as to stop the movement altogether. Gentle massage is usually advised to secure the dispersion of the solution through the surrounding parts. Notwithstanding the utmost care be used, if the injection be carried on too long, or if it is repeatedly performed in the same place, swelling and tenderness remain and an abscess may be produced. It is said that dangerous difficulty of breathing, almost asphyxia, has been brought on by injecting the fluid in the loose tissue above the clavicle. There are other situations available where the subcutaneous tissue is abundant and the absorption active. If the continuous method be employed, the place selected should be as little sensitive as possible, and should be so situated as to be undisturbed by the movements of the members. *Cæteris paribus*, the buttocks, the flanks, the axillary regions, and the space beneath the axilla are to be preferred.

As compared with intra-venous infusion of salines, hypodermatoclysis is far less quick in action, less powerful, and is safer. It must be said, however, that the danger of the intra-venous infusion or injection is trifling. There should, indeed, be no danger, if proper care be used. An advantage possessed by

hypodermatoclysis is that no assistant is required; it may be performed at once with the simplest means; whereas in the practice of the intra-venous method an assistant is necessary, and certain preparations must be made, before undertaking the operation at all. There are differences of opinion as to the therapeutic value of the two expedients. At Koch's Institute in Berlin intra-venous transfusion is preferred; at the Moabit Hospital, Berlin, Guttmann made use of hypodermatoclysis by choice. In Paris, the most active operator, Galliard, practised the subcutaneous infusion in three hundred cases, and seems satisfied with the result. During the recent epidemic at Hamburg, the hospital physicians, Hayse, Reiche, and Rumpf, employed both modes of saline infusion, but they prefer the intra-venous after an extended experience, because the curative results are greater. In general practice in the city, the subcutaneous was more largely used, because more convenient and easy, no assistant being required. Mathieu,[1] who had considerable experience in the Paris epidemic, advises the subcutaneous infusion in the mild cases only, and he gives 200 to 600 grammes—only about one-half of that given by most of those who have been quoted. Sirédey[2] injected Hayem's solution in the dose of 150

[1] Bull. gén. de Thérapeutique, December, 1893.

[2] Ibid., p. 542.

to 300 grammes, one-third only of that usually given, and of fifty-four serious cases, sixteen were cured. At New York quarantine they used the method of hypodermatoclysis only and with favorable results. All of the cases occurring in New York City, except two in which no bacteriological diagnosis was made, proved fatal; but we have no particulars as to the remedies employed in these cases.

The subcutaneous injection of sodium phosphate has lately been proposed as a substitute for the organic solutions—the testicular, the cerebral, and the cardiac, etc.—so strongly urged of late as remedies in low states of the system, and also in the algid stage of cholera. Dr. Crocq,[1] of Brussels, has lately come forward with this expedient—the subcutaneous injection of sodium phosphate—as a substitute for these organic solutions on the ground that their utility is really due to the presence of the phosphates, and that the same end can be attained by its administration subcutaneously. Luton, of Rheims, has lately also strongly advocated the sodium phosphate subcutaneously as a remedy when there is depression of the vital powers—in neurasthenia, in the algid stage of cholera, etc.—and he claims priority in this practice. His formula is as follows:

[1] Bull. gén. de Thérapeutique, March 30, 1893, p. 265. Les Injections Souscutanées de Phosphate de Soude, par M. Ed. Egasse.

R.—Sodium phosphate (cryst.) . . 5 parts.
Sodium sulphate . . . . 10 "
Water, distilled . . . . 100 "
Boil together and filter.

The sulphate is added to give the necessary density. This forms a clear, colorless solution entirely free from irritating qualities. The effect of the injection is not decided. It causes no pain and the slight swelling disappears in an hour or two. The systemic effects consist in some fulness of the head, and a general sense of warmth and diffused feeling of comfort and well-being. As no danger can occur from its administration, this expedient deserves a trial in cholera and it should be used freely.

When vomiting sets in actively and rice-water evacuations occur, the absorption of remedies by the stomach becomes most uncertain, with the probabilities against it. The rapid administration of remedies only adds to the distresses of the patient. Every one familiar with the care of cases of cholera knows how futile are the efforts to obtain results from the remedies; they may be retained for a time, but presently they come up with a loud explosive effort by regurgitation, and little, if any, is absorbed. The attempts to administer stimulants by the stomach are equally futile. Always with the failure of the vital powers, brandy and whiskey, champagne, and other stimulants are poured into the stomach; but the cir-

culation does not revive under their use, and in a short time they are regurgitated in the form in which they were taken. There are two expedients to be resorted to under these circumstances: irrigation of the stomach and the hypodermatic injection of remedies.

For *lavage* of the stomach a flexible œsophageal tube, a reservoir for containing the fluid, and a flexible tube for connecting the reservoir with the stomach-tube are the necessary parts. A flexible stomach-tube with a funnel-shaped orifice is sufficient for the purpose, to reduce the matter to its simplest form. The tube will act as a siphon. In patients asphyxiated, or insensible, or merely in a stupor, a stomach-tube must be introduced with care, the distal end being carried back to the posterior wall of the fauces to clear the glottis. It goes without saying that the apparatus should be carefully sterilized, and the water should be boiled in advance of the solution in it of acid, or of salines, or antiseptics. MM. Hayem and Lesage employed, with success, boiled water or hot water with boric acid in solution. They found that a single irrigation would sometimes arrest the vomiting; but it was necessary usually to repeat the operation in six to eight hours.

M. Delpech made use of a solution of lactic acid. It may have same strength as the boric acid solution:

℞.—Hot water	. .	1000 grammes	= 1 quart.
Boric acid	. .	4–8 "	= ʒj–ʒij.

Hayem, also, advocates irrigation with lactic acid solution. At the New York quarantine they made use of hydrochloric acid in the proportion of 1 : 1000, and as the comparative mortality was low, I assume that this expedient was a success.

It has been seen when the stomach was washed out that the contents of the organ apart from that thrown in or medicines or foods administered, consisted of the characteristic rice-water matter, and relief was felt when the organ was rid of it. To wash out the stomach is almost as necessary a part of the eliminant plan of treatment as enteroclysis. Besides, when the stomach is well emptied, vomiting often stops and the organ is then in a far better condition to absorb medicines and stimulants.

The hypodermatic method of administering remedies is a most important resource when the algid stage approaches, when the vomiting begins and everything is rejected as soon as swallowed, almost before it reaches the stomach. At the period of systemic infection, the only remedies that can oppose the action of the cholera toxine are such as corrosive sublimate and Klebs's anticholerine. It is only within a few months that attempts have been made to obtain the curative power of corrosive sublimate over the cholera infection. The duration of a case is so short that the antiseptic action of sublimate has but little space in which to operate. The dose must

needs be small, but it can be administered with comparative frequency:

℞.—Hydrarg. chlor. cor. . . . . gr. j.
Aquæ destil. . . . . ℥j.—M.

S.—Twenty minims for the initial dose, and ten minims every half-hour or hour.

Attempts have been made to reduce the power of the cholera toxine by successive cultures of the bacillus in or on various media. Thus far Klebs's anticholerine is the most opportune and successful product of the kind. Dr. Manchot[1] has made some trials of it in the Hamburg epidemic, and with results that promise well for future attempts. Of 31 cases treated with Klebs's anticholerine, 21 died, being a mortality rate of 67.7 per cent. If we compare this outcome with the method of transfusion of salines we find the result is greatly in favor of the anticholerine. Of 103 cases referred to by Manchot, which were treated by transfusion of salines, 87 died. The difference in favor of the anticholerine is no less than 16 per cent. It has been proposed recently to prepare an anticholerine by cultivating the comma bacillus with the juice of the thymus gland. Thus far it has not passed beyond the experimental stage.

Various agents have been utilized hypodermati-

[1] Centralblatt für die gesammte Therapie, December, 1892.

cally in the present epidemic to maintain the circulation. Dr. Trussewitsch, of Russia, employed with signal advantage injections of amyl nitrite and of ammonia. Sometimes the amyl nitrite was simply dropped on the tongue, and nitroglycerin injected. These agents act powerfully in raising up the heart-beat, by lowering the peripheral tension, thus permitting the circulation to be maintained with the minimum of effort on the part of the heart. Such an expedient is especially promising when by saline transfusion the blood has been prepared for active movement. Dr. Nedzwedzki[1] strongly advocates the subcutaneous injection of quinine, giving it in saline infusion. During the epidemic of 1876, in the south-west, atropine was quite largely used, alone and in combination with morphine, for the relief of the algid state. It has a specially good effect when saline intra-venous transfusion has preceded it. Under its action the pulse appears at the wrist, the skin becomes warm and dry, and the voice assumes a more natural character. My own experience has been with the morphine combination, where the powers of atropine are somewhat modified.

In Paris caffein was much used, and in combination with benzoate of sodium, according to this formula :

[1] St. Petersburger med. Wochenschr., 1892, No. 37. Centralblatt für die gesammte Therapie, November, 1892.

℞.—Caffein . . . 2 grammes = 3ss.
Benzoate of sodium 2 " 50 = 40 grs.
Water . . q. s. 10 c.c. = about 2½ drm.

A syringeful—about 20 minims—would therefore contain nearly 5 grains of caffein. This can be repeated every two, three or four hours.

At the Necker Hospital much confidence was felt in ether injections. A syringeful of ether can be given every fifteen minutes, or half-hour, and much relief is afforded by it to the muscular cramps. Cocaine has been found highly beneficial in the present epidemic. At Hôpital Beaujon it was used with success to arrest the vomiting, and by Dr. Kohos—who found it, in doses of from five to ten centigrammes, to arrest the vomiting, to relieve the cramps, and to increase the circulation. For the relief of cramp, in my experience, no agent is equal to chloral. It must be given hypodermatically, five or ten grains at a dose, dissolved in sufficient sterilized water. It affords prompt relief to the cramps, and restores warmth to the surface, by increasing the circulation. The efficiency of chloral is promoted by the previous or simultaneous administration of morphine and atropine. I have seen this combination effect marvels in the algid stage of cholera.

In my experience, the exhibition of alcoholic stimulants has been carried much too far. The thirst is excessive and the demand for drink constant, and

as the decline in the strength is rapid the temptation to supply the patient with stimulants is too great to be resisted. Who has not seen the drink swallowed with avidity brought up immediately, and the most potent of alcohol liquors taken in vain as regards any influence over the failure in the vital powers. The stimulants actually required should be injected subcutaneously, but deeply, into the loosest areolar tissue —from one to two drachms; or some pure alcohol may be added to the saline solution given by intravenous infusion or hypodermatoclysis.

During the present epidemic warm baths have an unusual prominence in the treatment of the algid condition. Formerly, bottles of hot water, hot bricks, and hot flannels were applied as the surface grew cold. Now baths in temperature from 100° F. to 104° F. are made use of, not, of course, for hygienic reason, but to supply a much-needed warmth. Winternitz, who is a leading authority on the water treatment in Germany, advocates the sitz bath at a moderate warmth, with frictions of the body with a towel wrung out in the water of the bath. Immersion of the patient in water at 104° F., followed by wraps of flannel and blankets heated to 105° F. Sirédey employed baths at 98° to 101° F., for ten to fifteen minutes, afterward wrapping the body in cotton or gummed taffeta, and applied mustard plasters. Lesage used baths at 40° C. (= 104° F.) of water

only, or of water and mustard. For those completely algid, the immersion of the body was persisted in for several hours. There are no data showing the influence of warm baths over the mortality rates of cholera, and I doubt whether they exercised any. As dry-heat is destructive of the comma bacillus, whenever practicable hot-air baths may be used. At Swinburne Island Hospital, New York Quarantine, the patients in the algid stage were placed near the hot-air radiators, so that they could receive the highest heat of the furnace (Daland).

When the first colored matters appear in the stools, and the secretion of urine begins, when the pulse can be felt at the wrist, and the respiration grows in volume and depth, convalescence has probably entered on its tedious course, or these appearances may prove delusive, and a typhoid state, or the condition known as uræmia, may be developing. If the stomach will retain them, such diluents as cream of tartar, lemonade, wine-whey, skimmed milk, hot, may be allowed. Champagne is always grateful to these patients, and may be taken freely if it agrees. At this stage irrigation of the intestine with salt solution is recommended by Sirédey, and if the diarrhœa persists, Cantani's enteroclysis with tannin proves useful. If the urinary secretion does not come on, or fails to increase, and the coma deepens, pilocarpine should be administered—one-eighth of a grain to one-fifth.

This may be repeated once or twice in the twenty-four hours. According to Dr. Duke,[1] of the Bengal Army, its action is "marvellous and rapid," thus confirming the observations of his colleague, Dr. Mullen, of the Bengal Army, who first suggested this use of pilocarpine. Not only when the urine is no longer secreted, but when the secretion is rapidly declining, is the period when the administration of this remedy should be begun. The curative power of pilocarpine is promoted by the simultaneous administration of strychnine, as has also been shown by Dr. Mullen, whose practice consists in giving five minims of liquor strychniæ (B. P.) which has the strength of one to one hundred and twenty, and is therefore equivalent to one twenty-fourth of a grain. After four to six hour, five minims are again injected, and was repeated up to fifteen or twenty minims in twenty-four hours. "The success of the remedy," says Dr. Day, "is known by the return of the pulse, frequently in twelve hours—and by the voice." Under the same conditions cocaine acts efficiently in bringing on the urinary secretion and in stopping the cramps which may still occur. From one-tenth to one-fifth of a grain is a sufficient dose, and this may be repeated every two, three, or four hours if the result of the first is favorable. When it

[1] Lancet, February 4, 1893, p. 244.

acts well, this fact is known by a reviving warmth of surface, by an increased diuresis, by return of the voice, and a distinct gain in muscular power.

As caffeine has active diuretic property, this may also be given to stimulate the renal function, either alone or in solution with benzoate of sodium. Also digitalin is an appropriate remedy to promote action of the kidneys, or the tincture of digitalis, may be administered in the same way. Quinine is an efficient agent at this stage—the typhoid state—especially when the reaction runs over into the febrile, and the patient wears the usual aspect of one in the lowest stage of the fever. Dr. Nedzwedzki, of St. Petersburg, likens the algid stage of cholera to a pernicious intermittent, and for this reason strongly urges the administration of quinine. His formula is as follows:

℞.—Hydrochlorate of quinine . . . 30.
Water . . . . . 100.
Common salt 0.6

Of this he directs the injection of two syringefuls, carrying about 18 grains of the quinine.

Alimentation is of the first consequence in the treatment of the reaction period. I have already indicated the kind of foods required. Solid foods must be avoided until digestion is resumed. Only liquid foods, as milk, wine-whey, koumiss, may be given at first, and even these must be given up if they

cause vomiting. When digestion is resumed a weak animal broth, soft-boiled eggs, sweetbreads simply stewed, or raw oysters, are suitable articles of diet. A very small quantity of food should be taken at a time; nor should the intervals of feeding be short. The ability of the stomach to dispose of food should be aided by the administration of pepsin and lactic and hydrochloric acids.

Having now passed in review the various remedies that have been proposed in the treatment of cholera, I intend giving an account of such plans or methods of management as the experience of physicians practising in the centres of cholera infection have most approved. We have many expressions of opinion from the physicians of Hamburg, where cholera has assumed its severest form, and of Paris, Berlin, St. Petersburg, and other places when it has been less severe, although eminently characteristic. Prof. Rumpf, of Hamburg, concludes from his observations that the most advantageous plan of treating cholera consists in the exhibition of calomel—a large dose at the outset, about eight grains, and smaller doses, one-half grain to two grains, every two, three, or four hours; prolonged hot baths at the temperature of 104° F. in the cold stage; intravenous transfusion of salines; small doses of morphine hypodermatically for the cramp, and the subcutaneous injection of ether and oil of camphor

as cardiac stimulants. During the diarrhœa stage Rumpf makes use of Cantani's enteroclysis, but finds it of little or no avail afterward, and he no longer depends on salol, creolin, and other intestinal antiseptics, having seen their inefficiency. He is, also, opposed to the use of opium in any considerable quantity, especially by the stomach, because it brings on a paresis of the intestine and deepens the stupor of the algid stage.

Prof. Cantani,[1] of Naples, has brought into use two new expedients for the treatment of cholera—enteroclysis and hypodermatoclysis—and has also been active in promoting intra-venous infusion of salines. He affirms that he invariably cured cholera diarrhœa by means of enteroclysis. Many remedies will arrest the diarrhœa that are quite powerless in the algid stage, and this is not an exception to the rule. Cantani assumes that the fluid will always pass through the ileo-cæcal valve, an assumption not warranted by the facts, Daland's experiments having shown that in one-third, certainly, the fluid does not pass into the small intestine. Cantani also advocates his method of hypodermatoclysis as a substitute for venous infusion of salines.

Dujardin-Beaumetz's treatment at the Hôpital Cochin, Paris, was as follows: Those admitted in the

[1] Berliner klinische Wochenschrift.

algid state were enveloped in blankets and surrounded by bottles of hot water. Lactic acid was administered every quarter of an hour—three tablespoonfuls of this mixture given at a dose:

℞.—Lactic acid .	10 grammes	=	155 grains.
Simple syrup	20 "	=	½ oz. (nearly)
Tinct. of citron	2 "	=	ʒss.
Water (steril.)	1000 "	=	1 quart.

To arrest the vomiting, bits of ice were swallowed; iced milk and carbonated waters were also allowed. Every hour twenty drops of paregoric. Sometimes Lausedat's drops were given, as follows:

℞.—Ethereal tincture of valerian .	5 grammes
Laudanum	1 gramme.
Essence of mint . . .	5 drops.
Hoffman's anodyne . . .	5 grammes.—M.

S.—Twenty-five drops were given for the vomiting and diarrhœa.

Against the cramps, small doses of morphine were administered subcutaneously, and against failure of the vital powers, injection of ether and caffein were employed. Intra-venous infusion of salines according to the formula of Hayem was used, as follows:

℞.—Water distilled and steril.	1000 grms.	=	1 quart.
Chloride of sodium .	5 "	=	77 grs.
Sulphate of sodium .	10 "	=	155 "

At the Hôpital Cochin, also, they irrigated the

stomach with recently boiled water containing some boric acid, according to the method of M. Bourcy. The intestines were irrigated by a naphthalized solution, twenty centigrammes to one thousand grammes in strength, an œsophageal sound being passed up as far as possible to carry the fluid high up in the intestines.

At the military barracks in Hamburg they employed Cantani's tannin enteroclysis, lactic acid, and resorcin by the stomach, but especially calomel. Both intra-venous infusion and hypodermatoclysis were resorted to, the advantage, however, remaining with the former. In Paris, Dr. Mathieu gave chloroform water, champagne, and sterilized milk, and sixty to eighty grammes of talc[1] in wafers, per day. Against the cramps he employed injections of morphine, and of cocaine, dry friction massage, and warm baths. M. Delpech reports excellent results from the use of creasote—two to three grammes—by irrigation.

I must not fail to describe the treatment pursued at New York quarantine,[2] which, although similar to that made use of abroad, had some special features of its own. The "suspects" were required to drink freely of hydrochloric acid lemonade 1 : 1000, and

[1] Silicate of magnesia.

[2] The American Journal of the Med. Sciences, January, 1893: Wilcox, Epidemic Cholera in New York.

lavage of the stomach was practised with the tannin solution, or with hydrochloric acid 1 : 1000, every two hours. The intestines were washed out with a two per cent. aqueous solution of tannic acid, half a gallon being used at a time at a temperature of 108.9° F., and repeated every two hours. A rectal tube two feet in length was introduced as far as could be done, and when there was difficulty in securing passage of the fluid through the ileo-cæcal valve, massage of the abdomen was practised to overcome the resistance. At the outset ten grains of calomel were given, and this was repeated every hour until three doses were taken, or thorough evacuation secured. Afterward one-half grain was administered every two hours. Stimulants were used as required, preferably brandy, and generally administered hypodermatically. When the algid stage came on, hypodermatoclysis was resorted to, the solution employed consisting of "sodium chloride 3 parts, brandy 10 parts, to 1000 parts of sterilized water kept at a temperature of 104° F. One quart was used for an adult, and it was injected into the flanks at about the eighth rib, and was repeated every second to fifth hour according to the necessities of the case. The largest amount used in any one case was eleven quarts."

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